Heating Piping & Air Conditioning

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OCT.—NOV. ★ 1945

INDUSTRIAL
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557 — Journal Section of the American Society of Heating and Ventilating Engineers

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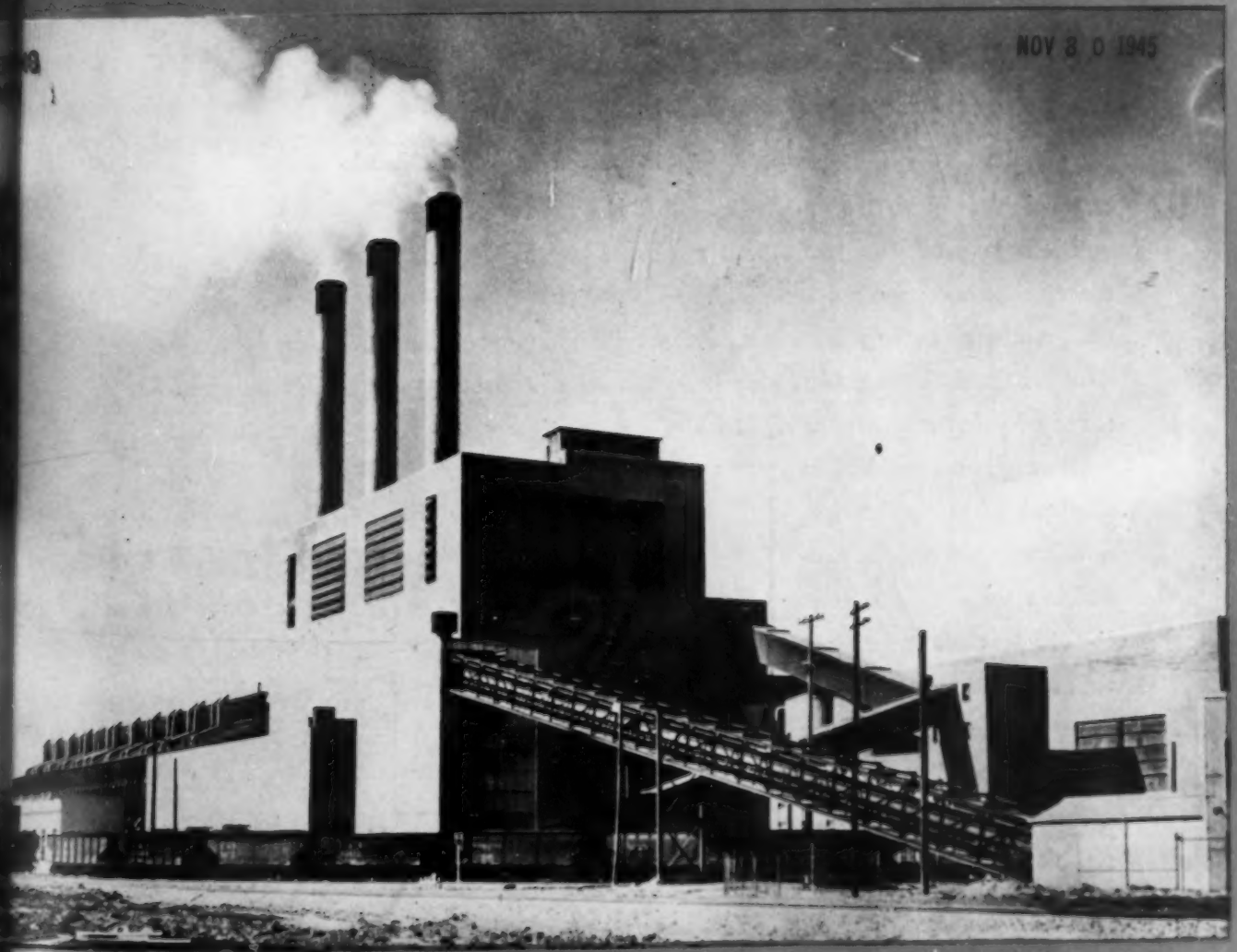

Splitting the atom involves unusual piping techniques, briefly discussed in this issue. Shown here is a steam plant at Oak Ridge

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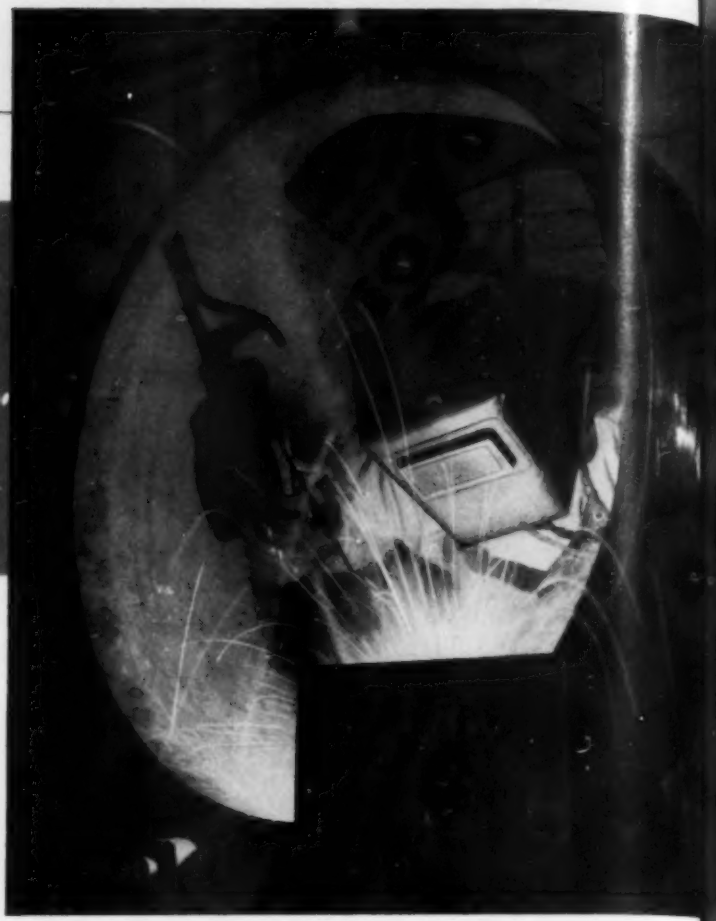
A fast way to get motors...



This suggestion is not addressed to buyers who use standard motors, although for them Star also has good news: Star began production of a large range of standard motors for stock weeks ago, and early delivery of some of these can be made.

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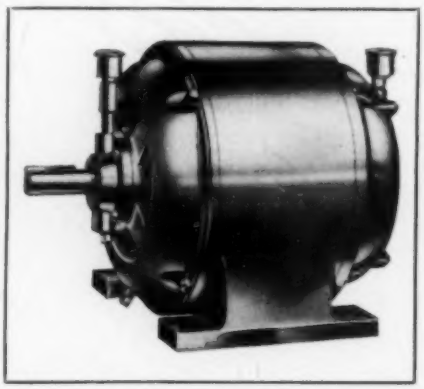

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STAR MOTORS

POWER PACKAGED AS YOU NEED IT

TO OUR READERS

YOUR October and November numbers of Heating, Piping & Air Conditioning are combined in this one issue. It was impossible to get out our October issue in its regular form and on its regular publication date because, throughout most of that month, the operations of the large union printing plants in Chicago were suspended by a strike of the local typographical union. It is in one of those plants that we contract for the printing of our magazine.

With the resumption of work, so much time had been lost and printing facilities were so jammed it would be months before we could get on schedule if we tried to go back and publish our October issue and then our November, December, and succeeding regular issues.

Thus, this combination October-November issue was the only solution and, though in one package, we have incorporated in it as many features as possible that would normally have been in the two separate issues. You will note that the editorial content is well in excess of that of a normal issue. What is necessarily not included in this issue will be made up as extra material in succeeding issues.

As a result, we have not permitted this situation to cause any reduction in our reader service. We are sorry that it has meant a delay.

We are grateful to our readers for their patience and know that they will understand that our experience was completely beyond our control. We are grateful, too, to our advertisers whose schedules were delayed and, in some cases, interrupted, but who, in every case, have willingly shifted to accommodate these changes.

Our future issues will be on regular publication dates.

THE *Editor's Pages*

WITH HPAC'S CONTRIBUTING EDITORS

Dr. F. E. Giesecke, a member of HPAC's board of consulting and contributing editors, has resigned from the staff of the A. & M. College of Texas after 59 years of service in the field of education, 44 of which were spent at A. & M. He and Mrs. Giesecke will make their home at New Braunfels, Tex., and Dr. Giesecke will devote part of his time to professional work as a consultant in the field of heating and ventilation.

He is a past-president of the American Society of Heating and Ventilating Engineers, of which he is a life member, and the author or co-author of more than 75 technical bulletins and magazine articles, as well as books on technical drawing, descriptive g e o m e t r y, hot water heating, and radiant heating.

* * *

Charles S. Leopold, consulting engineer specializing in air conditioning, and a member of HPAC's board of consulting and contributing editors, has been nominated for national president of the American Society of Refrigerating Engineers. Invited to guest membership in the ASRE in 1934, he has since served as a director and as vice-president.

* * *

John J. Harman, member of HPAC's board of consulting and contributing editors, is retiring as general secretary of the Manufacturers' Standardization Society of the Valve and Fittings Industry, and moving to southern California. Mr. Harman has had a long and distinguished career in the piping industry, and has written articles on valves, piping viscous liquids, and other piping subjects which have appeared in HPAC.

L. W. Benoit, formerly connected with the Reading-Pratt & Cady Div. of the American Chain & Cable Co., Inc., succeeds him as general secretary of the society.

HOTEL GUESTS VOTE FOR AIR CONDITIONING

Ninety per cent of those who replied to a questionnaire sent out by Frank L. Andrews, president of the Hotel New Yorker, indicated that they were in favor of more air conditioning in guest rooms, and 75 per cent said they'd be willing to pay more for a room which is air conditioned.

In April of this year, the hotel mailed the questionnaire—a 20 page booklet, illustrated with informal sketches—to its list of 69,833 credit card holders, and received 17,160 replies. Sixteen major questions, divided into a total of 36 sub-questions, were asked and a self-mailing reply sheet was included.

DEPARTMENT STORES INSTALLING A.C.

The nation's department stores, set to spend $60,000,000 for new air conditioning equipment, are losing no time in getting that phase of their projected billion dollar modernization program under way, according to the Refrigeration Equipment Manufacturers Association.

Mandel's, in Chicago, already has put in operation a new 800 ton compressor unit to service four floors of a 16 story building; the installation takes the place of a 300 ton unit used during the war by the War Production Board in a synthetic rubber plant in the south. Although it serviced the same four floors, including restaurants, tearoom, beauty and fur salons, and women's ready-to-wear departments, the fact that the store d e c i d e d on a more than doubled capacity is indicative of the added stress being put on air conditioning, says REMA.

Improvements i n department store air conditioning systems — use of new refrigerants and of evaporative condensers—make conditioned air even more attractive than before the war from a sales standpoint. However, it is believed by REMA that the "saturation point" in air conditioned department stores will not be reached for 15 to 20 years.

Comments from various sales heads of Mandel's, where some 100 departments are air conditioned, show the influence cooled and conditioned air has on business volume.

The fur buyer, for example, said that during the hot summer months before air conditioning, customers rarely stayed long enough to try on two or three coats. Now, they remain until they have purchased or seen the full stock. Fall hats are popular in the warmest weather, the millinery manager reported. Restaurant patronage has been maintained during the summer. Beauty shop and shoe department patronage, too, has been maintained in hot weather.

CRAWFORD ELECTED ICI PRESIDENT

At the second annual meeting of the Indoor Climate Institute recently held at the Book-Cadillac in Detroit, T. A. Crawford, general manager of the Timken Silent Automatic Div., Timken-Detroit Axle Co., was elected president, succeeding Paul B. Zimmerman, who has held the office since inception of the institute. L. N. Hunter, National Radiator Co., was made first vice-president and R. E. Moore, Bell & Gossett Co., and E. N. McDonnell, McDonnell and Miller, were re-elected secretary and treasurer respectively.

Elected to the board of directors were Paul K. Addams, Fitzgibbons Boiler Co., Inc.; A. T. Atwill, Quaker Mfg. Co.; C. T. Burg, Iron Fireman Mfg. Co.; Thomas Byrd, Lau Blower Co.; R. C. Cameron, Chrysler Co., Airtemp Div.; Bruce T. Cunningham, Research Products Corp.; J. K. Knighton, Servel, Inc.; C. E. Lewis, Perfex Corp.; C. D. Lyford, Minneapolis-Honeywell Regulator Co.; J. M. McClintock, Freeman Stoker Div., Illinois Iron & Bolt Co.; J. P. McIlhenny, Air Conditioning Dept., General Electric Co.; Joseph R. Murphy, Taco Heaters, Inc.; C. A. Olsen, C. A. Olsen Mfg. Co.; Gordon Rieley, Bryant Heater Co.; Jack Searls, White-Rodgers Electric, and Martin Weil, Weil-McLain Co.

MORE LIGHT ON DUST

To the highly versatile electron microscope has been added still another important function: the determination of the size, distribution, and shape of infinitesimal particles of dust and pollen in the air. A subject of considerable interest to the air cleaning industries, the study of these particles has been limited by the magnifying power of the light microscope, which can give information only on particles above 5 microns in size.

But the electron microscope, with its magnification of up to 50,000 diameters, can recognize particles as small as 0.005 micron, and can determine the form of those 0.02 micron or larger. Doctors E. A. Gulbransen and R. T. Phelps of the Westinghouse research laboratories are making such studies on particles of dust, tobacco smoke, and pollen, collected from smoggy, rainy, and clear atmospheres.

THE Editor's Pages

Because the electron microscope can penetrate matter to a depth of only 0.01 to 0.05 micron, the specimens must be collected on an extremely thin film of collodion or other plastic material. This, in turn, is mounted on a 200 mesh stainless steel screen ⅛ in. in diameter. Tobacco smoke particles can be collected by holding the film and screen in a trail of smoke for a few seconds. Dust can be gathered electrostatically by making the specimen the negative electrode and a fine point the positive electrode. A large collection of dust, smoke, or pollen can either be dusted on the screen or film, or dispersed in water and a drop evaporated on the screen.

The studies made so far show the effectiveness of the electron microscope in studying air cleaning problems. Not only can the nature of the foreign material in the air be studied, but also the efficiency of the air cleaning process itself can be evaluated.

REMA ENVISIONS "COLD CENTERS"

Complete "cold centers," serving entire communities or towns and offering services ranging all the way from the storage of furs and blankets to the processing and storage of frozen foods, are envisioned by the Refrigeration Equipment Manufacturers' Association.

The idea of "general refrigeration stores" is just as logical as supermarkets, department stores, or even hospitals, REMA officials say. The "cold centers," in addition to serving retail customers, also could supply commercial refrigeration requirements—aging meat for nearby butcher shops, for example, or storing perishable foods for restaurants and hotels.

ECONOMISTS OPTIMISTIC ON RECONVERSION

America has a good chance of getting through the reconversion period without mass unemployment or severe business dislocation, according to substantial opinion among six of the country's leading economists who are participating in a symposium sponsored by the Twentieth Century Fund.

The economists represent a wide range of viewpoints and they differ most sharply on the amount of action by the federal government that may be indicated both for the country's long-term prosperity and for the transition period. Most optimistic among the six on the question of reconversion problems is Sumner H. Slichter, Lamont university professor at Harvard. He says: "Fears of large and prolonged conversion and deflation unemployment appear to be ill founded. . . . The engineering obstacles to conversion are much less formidable than is commonly supposed. . . . The capacity of the civilian economy to absorb people promptly is greater than is generally realized."

Slichter believes that "the great majority of war workers" were doing exactly the kind of work during the war they will do in time of peace. He cites farming, railroading, iron and steel, textiles, clothing, shoes, petroleum, electric light and power, aluminum, paper, lumber, chemicals, and machine tools as examples of important industries in which this is true.

"Only about 5 million war workers were employed in plants (aircraft, ships, guns, explosives) which will make large permanent layoffs or which will have major engineering problems of conversion," Slichter asserts. "Indeed, only about 10 per cent of war workers were in plants where engineering problems of conversion will halt production for as long as four months. . . . No engineering difficulties will retard the opening of thousands of jobs in filling stations and garages as people are able to drive their cars freely or the prompt filling of thousands of jobs now crying for people in stores, banks, hotels, restaurants, or on farms or in building repair work."

Heating Piping & Air Conditioning

with which is merged the Aerologist

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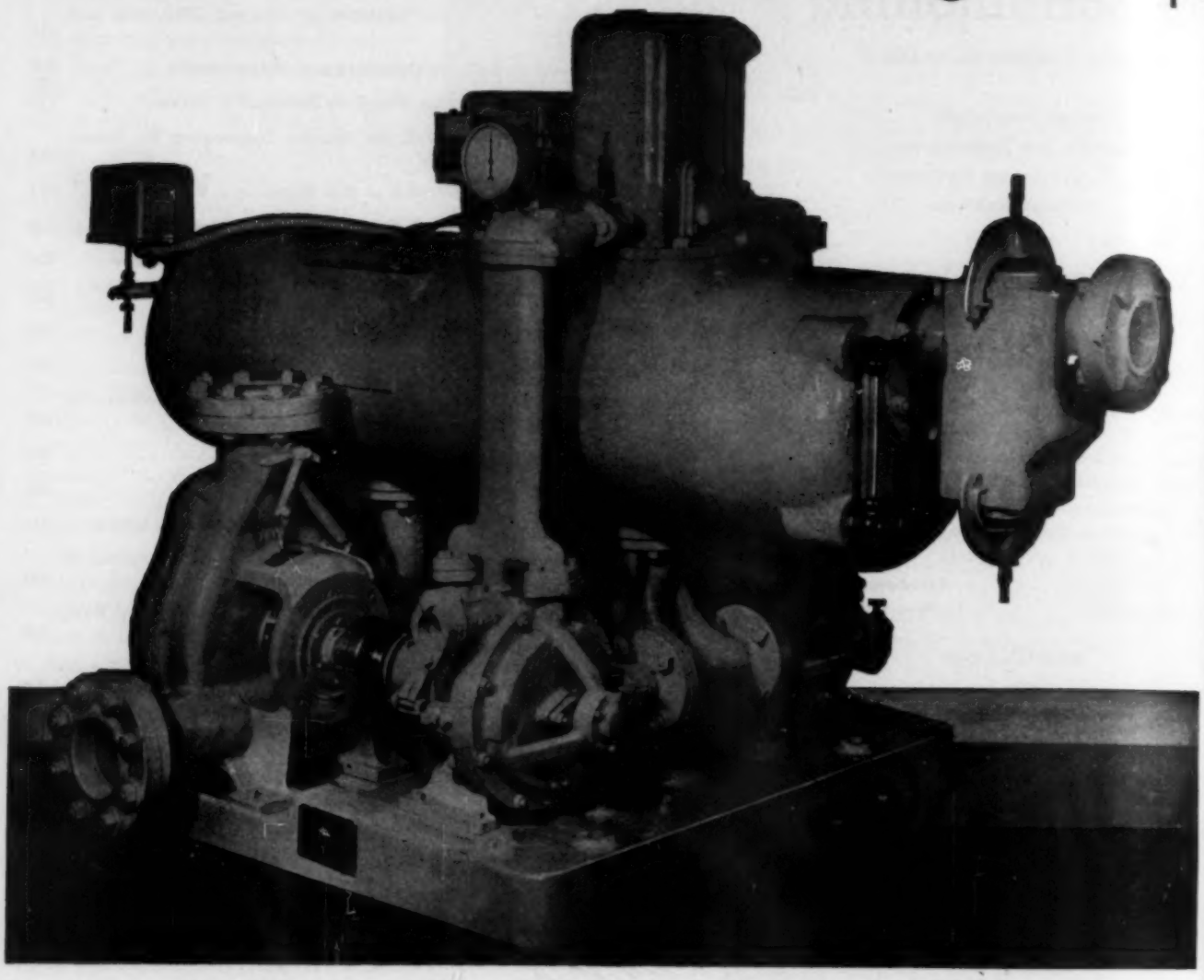
Where Heat Must Not Fail– Install this SAFE Heating Pump!



In Hospitals, Greenhouses, Schools, Public Buildings, Theatres, wherever heating systems must not fail, install the Nash Vapor Turbine, for it is entirely independent of electric current failure, and continues to operate as long as there is steam in the system.

More than that, the Vapor Turbine is a most economical pump, for the elimination of electric current does away with current cost, the largest single item in the operation of an ordinary return line heating pump.

Greater savings still are effected by the Vapor Turbine in the system, for the reason that this pump operates continuously. It is the only pump that can do this with economy. Continuous operation means uniform circulation, and uniform circulation saves steam.

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THE NASH ENGINEERING COMPANY

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SURFACING TECHNIQUES for THERMAL INSULATION on hot and cold PIPES AND DUCTS

By E. T. Cope, Research Department
The Detroit Edison Co.

MOST OF THE articles on heat insulation published during the past quarter century have dealt primarily with methods of determining thermal conductivity or procedures for determining the economical thickness of insulation for any given set of conditions. These phases of the subject have been discussed fully, but very little has been written regarding means for insuring continuing effectiveness and good appearance of the insulation, particularly the jacketing or external surface.

In the present paper, several types of application are discussed with respect to what has been or could be done to maintain the good appearance and effectiveness of the insulation. The examples given are all taken from installations in The Detroit Edison Co.

Case 1—Straight Pipes Carrying Hot Fluids at More than 600 F

An example of this type of application in which proper measures to maintain the appearance of the insulation were not taken is shown in Fig. 1, which shows a 14 in. pipe carrying superheated steam at 720 F. The insulation consists of two layers of high temperature blocks 36 in. long. The voids between the blocks were filled with insulating cement and the outside surface of the blocks was finished smooth with asbestos finishing cement. Jacketing consisted of 6 oz duck pasted on and, when dry, painted with two coats of a good grade of pipe line enamel of appropriate color.

When new, this assembly was neat and trim; however, during the course of the first few months, after the piping had been in and out of service a few times, the difference in linear expansion of the pipe and the jacketing produced the wrinkling at the joints of the insulation that stands out so prominently in the picture. After a few years of service, the jacketing will undoubtedly crack at the wrinkles and the appearance will be even less satisfactory. Unfortunately there is not much that can be done to correct this condition.

Fig. 1—Appearance of outer surface of steam piping insulation in which expansion joints were not provided. Construction shown is double-layer block covering

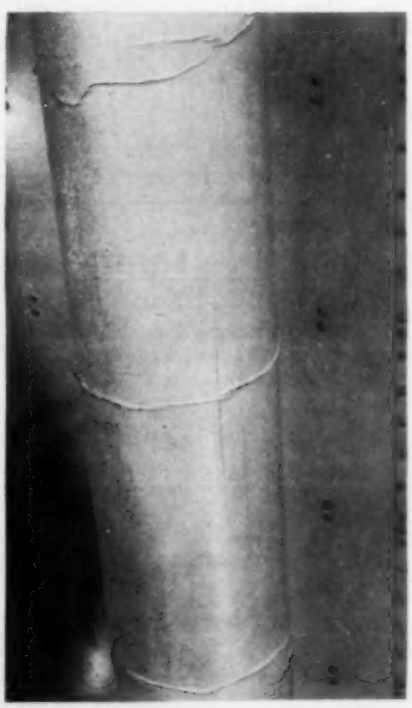


Fig. 2 shows what has been accomplished with respect to this jacketing problem by a few changes that not only simplified the design of the insulation but also effected a slight reduction in cost. The essentials of the new design are shown in Fig. 3. This construction may be made from single layer insulation in sectional or segmental form fabricated from any acceptable material or combination of materials. The inside diameter of the insulation should be larger than the outside diameter of the pipe to a degree sufficient to insure free longitudinal movement at operating temperature. Three 3 ft sections of insulation are assembled according to the usual technique to form a 9 ft unit on the pipe. The ends of each 9 ft unit are finished square, making "through" butt joints with adjacent 9 ft units. The three sections of insulation forming a 9 ft unit are stapled together at the two circumferential joints and the outside surface is finished smooth by troweling on a thin layer of asbestos finishing cement. Six ounce duck is then pasted on and, when dry, painted. This method of assembly produces a rugged 9 ft. length of insulation that is slightly loose on the pipe. Adjacent 9 ft

Fig. 2—New technique for insulating steam piping using single-layer sectional pipe covering with expansion joints

ANTICIPATED SAVINGS effected by heat insulation can be expected only if the material is installed carefully and jacketed so that the surface will withstand normal operating conditions; periodic inspection and repairing are as necessary with heat insulation as with any other plant equipment. The author has found that painted canvas has proved to be satisfactory as jacketing on the insulation on hot pipes and ducts if provision is made to eliminate wrinkling by expansion joints and the surface is repainted regularly every three to five years. It is his experience, however, that painted canvas is not a dependable vapor barrier for use on the insulation on cold pipes and ducts. Latex - emulsion - impregnated canvas has been used successfully and some of the plastics would probably be satisfactory in place of latex . . . The departures from current insulation and jacketing practice discussed in this paper are the results of a persistent desire to use the available insulating materials more effectively and at the same time effectively maintain the good appearance of piping and ducts without undue maintenance.

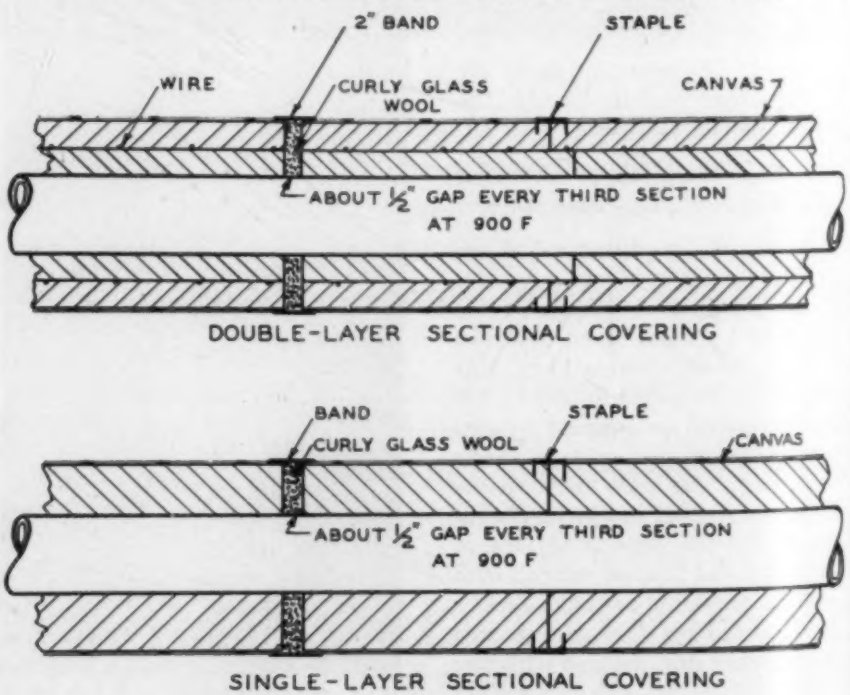
lengths are assembled in a similar manner.

After the installation of the insulation is completed, steam is admitted to the pipe. The difference in thermal expansion of the pipe and the insulation causes the butt joints to open. This may amount to ½ in. in piping such as is pictured in Fig. 3. The open joints, which may be called expansion joints, are then packed with curly glass wool and a metal band is fitted over the joint and tacked to the insulation on one side only. These bands are painted when the final coat of paint is applied. The "come and go" resulting from heating and cooling cannot produce wrinkles in the jacketing and the neat appearance of the pipe line is assured.

It should be noted that the location of pipe hangers on both horizontal and vertical runs of piping often makes impossible the exact execution of this plan, as regards the 9 ft units, because the distance between successive hangers is not usually an exact multiple of 9 ft. In the cases where the span is not a multiple of 9 ft, the construction is made to approximate as closely as possible the 9 ft unit design. The pipe hangers are encased in the covering, thus anchoring the covering, and the expansion joints are located toward the middle of the span.

The "through" butt expansion joints that are an essential feature of the assembly shown in Fig. 3 may be considered by some engineers to be an avenue of escape from the pipe of an excessive amount of heat. That such is not the case is illustrated in Fig. 4. These sections of insulation were first impregnated with a temperature-responsive indicator and then assembled on a pipe of appropriate size carrying steam at 950 F. The joints in this test were not filled with glass wool and not covered with a band. It will be noted in the figure that the dark, isothermal lines are not bent at the butt joints, thus indicating that no excessive flow of heat occurred through these portions of the covering.

Fig. 3—Assembly of sectional insulation for high-temperature pipes



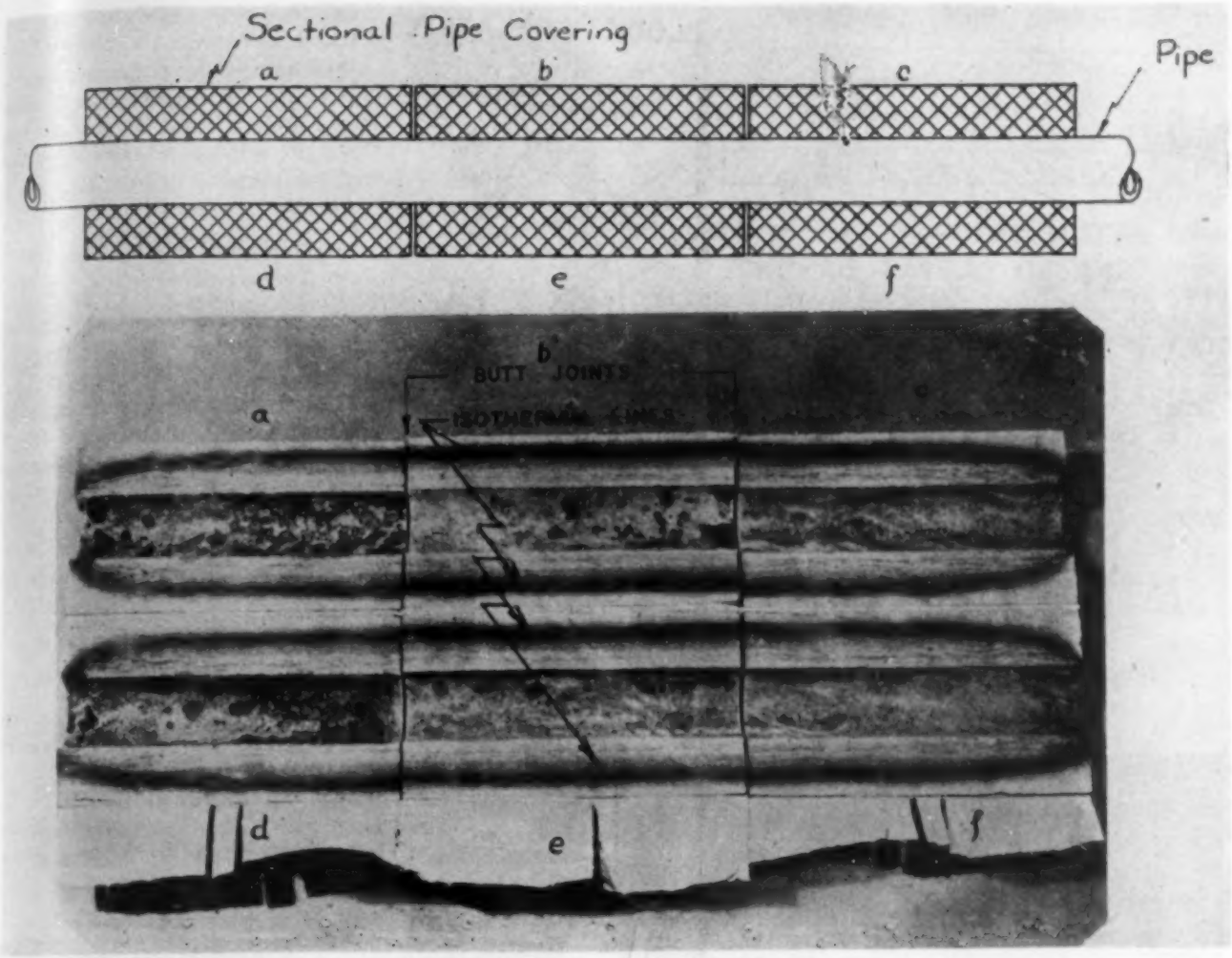


Fig. 4—Demonstration that through butt joints do not change heat flow through insulation. (Line drawing at top indicates scheme of assembly in which the covering pictured was tested)

Case 2—Curved Pipe Carrying Fluids at More Than 600 F

The jacketing on the curved portions of high temperature pipe is even more difficult to maintain in good condition than is that on straight lengths of pipe. The usual construction, either with preformed block insulation or with sectional insulation miter-cut to fit approximately on the pipe, does not provide for the expansion of the pipe. The construction shown in Fig. 5 is suggested as a solution to this problem. In principle this is an adaptation of the technique shown in Fig. 3. The only change from the previously described procedure in covering this shape of structure is to place the "through" joints at intervals of 3 ft. Metal bands are provided similar to those described in connection with Fig. 4. With the success attained with the jacketing on straight pipe, it is believed that the proposed treatment would be successful on curved pipe.

Case 3—Flat or Nearly Flat Surfaces Having Metal Parts at Elevated Temperature Extending Through the Insulation

In this group one finds the bodies of valves in steam piping and the bodies and covers of valves on steam turbines. Fig. 6 shows an example in which improved materials were not used. As might be expected, the temperature of the outer surface of the insulation adjacent to the protruding part of the valve was much higher than that found on any other part of the external surface. The jacketing, which was made from cotton duck, quickly charred and became useless when used on the parts near the protruding metal. In this condition, in addition to being unsightly, the jacketing offered no protection or reinforcement to the insulation. Corrective measures that have been applied with success in this case consisted in substituting asbestos cloth for the cotton duck. Fig. 7 shows such a treatment. An alternative treatment would have been to substitute glass cloth made from high-temperature-resisting glass for the asbestos cloth.

A second example of the use of unsatisfactory materials in an application of this type is that of the jacketing on the insulation on the throttle valve of a 75,000 kw steam turbine operating on steam at 900 F. The jacketing originally applied was 6 oz duck pasted onto the insulation. An inspection of the insulation made after the turbine had been in operation about a year and a half revealed that the jacketing on the throttle valve body and on adjacent portions of the turbine casing was charred so that it could be brushed off with the hand. A cloth made from high-temperature-

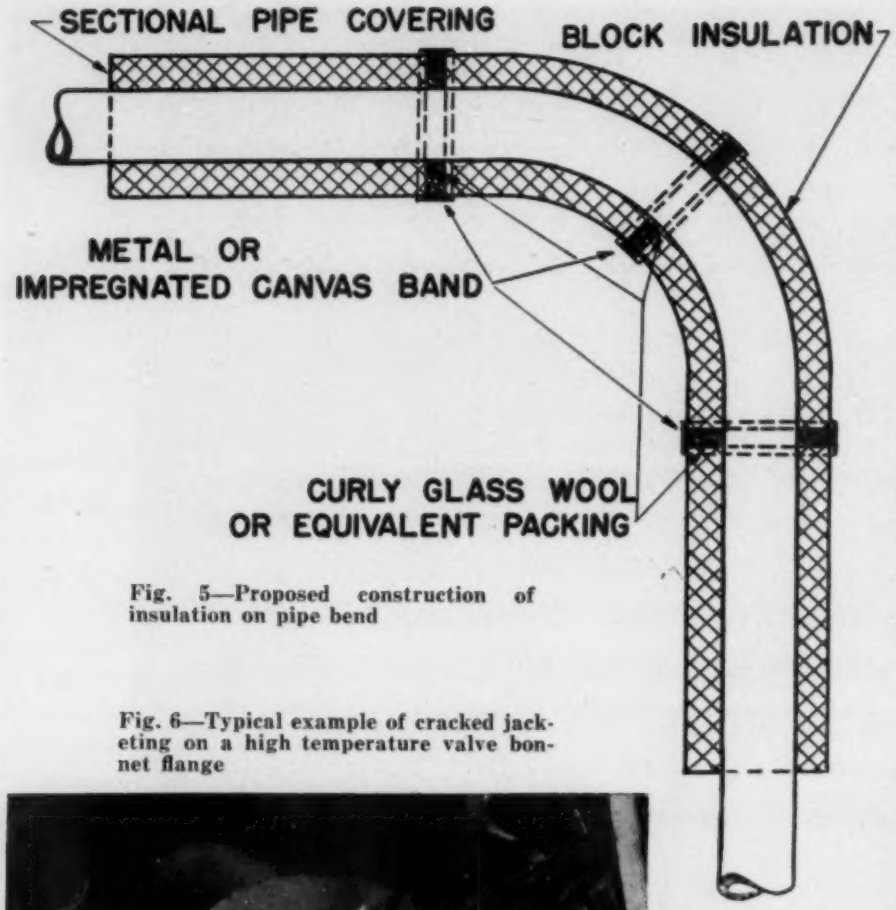


Fig. 5—Proposed construction of insulation on pipe bend

Fig. 6—Typical example of cracked jacketing on a high temperature valve bonnet flange

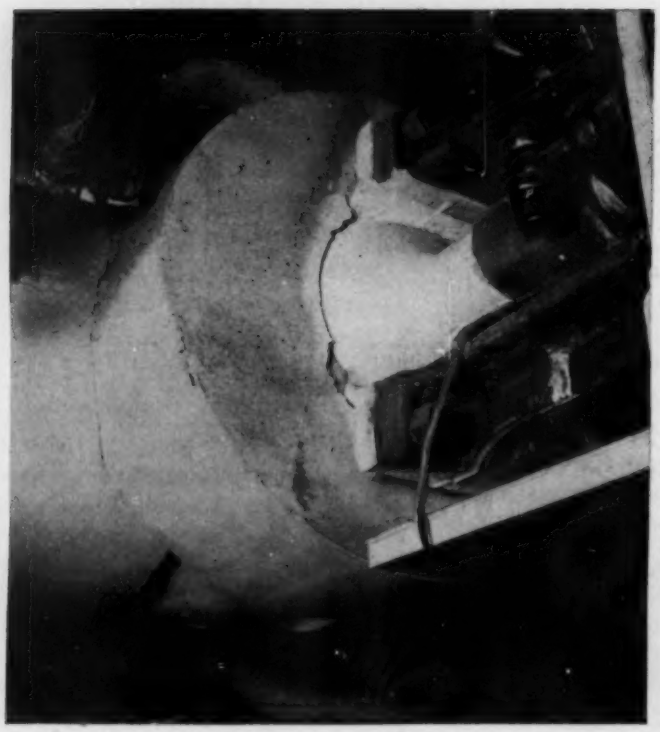
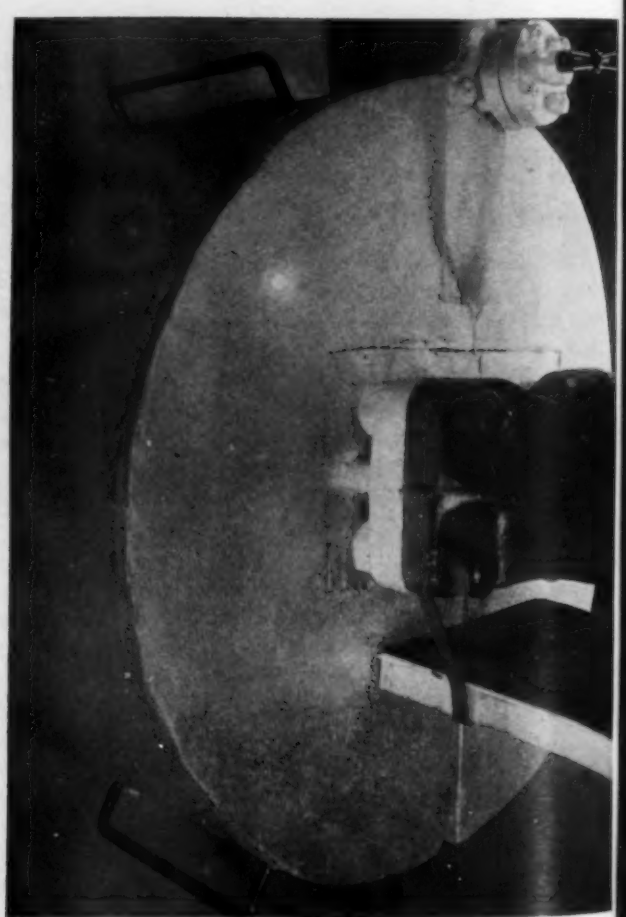


Fig. 7—Typical installation of asbestos cloth on the face of a high temperature valve bonnet flange



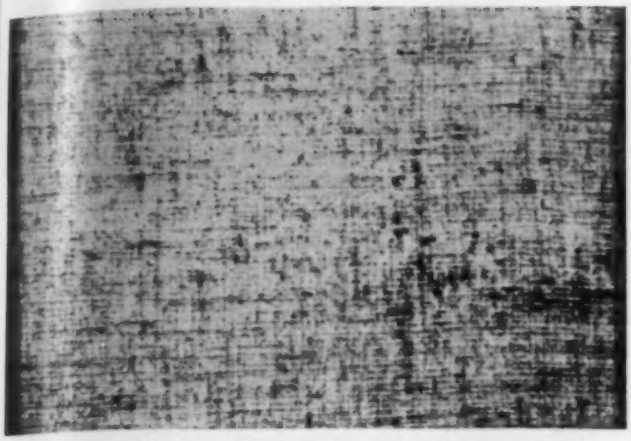
resisting glass was used for rejacketing these areas. Sodium silicate was used as the adhesive. An inspection of this jacketing made some time after the turbine was back in service revealed that the use of glass cloth had apparently corrected this condition.

Case 4—Pipes Carrying Hot Fluids at Temperatures below 600 F

The design of this type of insulation offers no problem affecting the maintenance of jacketing on insulated piping operating at temperatures below about 600 F if ordinary precautions are taken in installing and maintaining the insulation and its jacketing. Periodic painting of the jacketing will prolong its useful life and maintain its good appearance.

Case 5—Ducts Carrying Hot Fluids

The jacketing of insulation on hot air ducts and breeching has presented difficulties that have not as yet been solved satisfactorily. The reason for this is that the large flat areas of the ducts are subject



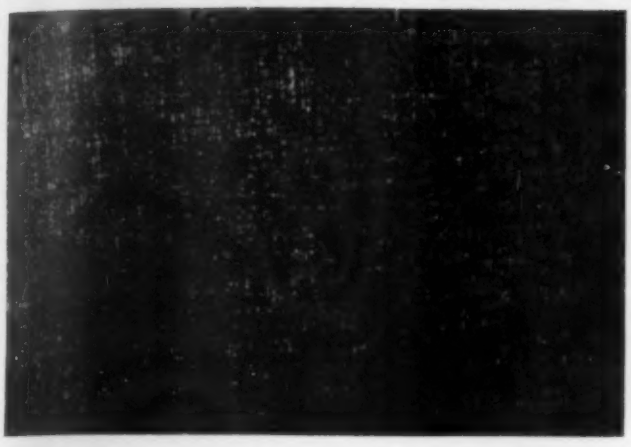


Fig. 8—Ineffectiveness of a single coat of oil paint on canvas as a surface seal for chilled water piping insulation. Above: One coat of oil paint on 2½ oz canvas furnished commercially on pipe covering. Below: One coat of oil paint on 6 oz canvas

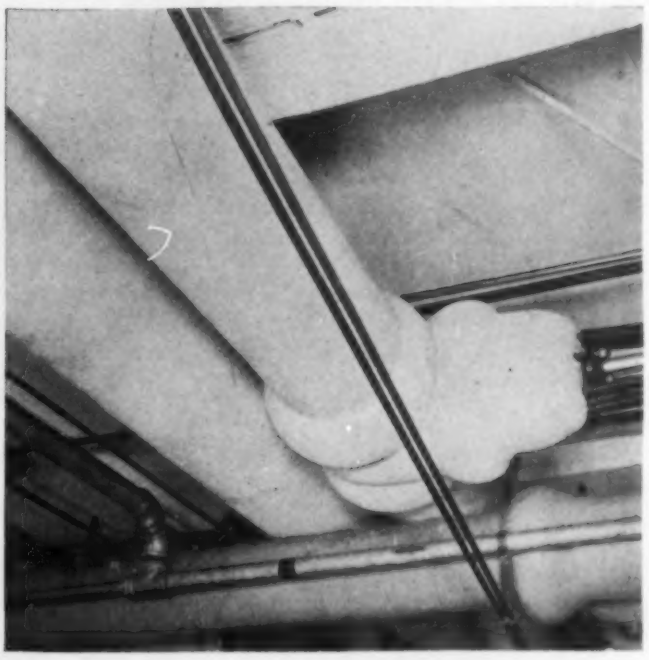


Fig. 9—Completed installation on chilled fluid valve body using latex-impregnated 6 oz canvas as jacketing

to warpage and vibration as well as to expansion due to changes in temperature. The resulting irregular movement makes the construction of expansion joints in the insulation difficult and expensive. Many attempts have been made to overcome the difficulties encountered, but as yet no simple and low cost design has been devised.

Case 6—Pipes and Ducts Carrying Cold Fluids

Jacketing on pipes and ducts carrying fluids below room temperature must prevent the entrance of atmospheric water vapor. It must be a vapor barrier. Painted canvas has been used in the past but it does not effect a permanent seal. In fact, unless the paint is of good quality and is used generously, no seal is produced. The photographs in Fig. 8, which were taken by transmitted light, illustrate the ineffective sealing furnished by one coat of a good grade of pipe line enamel applied to 2½ oz and to 6 oz duck. It is obvious that the interthread spaces of the 2½ oz duck have scarcely been closed at all and that there are many interthread spaces unfilled in the 6 oz duck. A second coat of paint might temporarily close the spaces in the 6 oz duck. Even if the second coat of paint did seal the jacketing, the seal would have a relatively short life because of the aging and subsequent cracking of the paint. This well known trait of paint makes it a very unreliable barrier against atmospheric water vapor. This fact led to experimenting with latex emulsion sprayed on 6 oz cotton duck as a surface seal for the insulation on approximately 1000 ft of 10 in. cold water pipe. The details of this investigation have been published in Heating, Piping & Air Conditioning for December 1940.* Fig. 9 shows a portion of the pipe under discussion. This piping has been in service five years and the performance has been so satisfactory that it is believed the following progress report on the performance of this installation will be of interest to anyone responsible for the operation of cold fluid systems.

After five years of operation, the latex-impregnated canvas jacketing is still pliable and shows no signs of deterioration. The insulation that carries the weight of the pipe and contents at the supporting saddles has deformed to some extent and the jacketing has wrinkled somewhat but there is no evidence of cracking. After a period of four years, one wet spot had developed and the insulation was readily replaced. In order to make as simple a job as possible of the removal and replacement of the wet material (only the lower half of the insulation was water soaked), the jacketing was slit for about 4 ft lengthwise of the lower side of the covering and then cut halfway around the pipe at each end of the slit. The water-soaked part of the insulation was then removed. When the pipe was exposed, a welded joint was found at the middle of the length of the wet section. Investigation did not reveal whether the water found in the insulation had entered as vapor through the jacketing and had condensed on the pipe at an accessible point where a weld happened to be, or whether the water leaked through a small pinhole in

* New Technique Developed for Insulating Cold Fluid Piping, by E. T. Cope and W. F. Kinney.

the weld that had been finally closed by rust.

New insulation was fitted onto the bare portion of the pipe and all voids filled with insulating cement. The cement was dried by the use of infra-red lamps. The jacketing that had been slit and loosened on the lower portion of the pipe was drawn back into place and pasted and stapled to the insulation. New 6 oz canvas jacketing that had been impregnated with an air-setting plastic† (latex emulsion was not available) was carefully stretched over and sealed to the portion of the insulation where the repairs were made. After the plastic had set, the surface was painted with cold water paint. This repaired portion has passed through one cooling season without evidence of a recurrence of the trouble. It is doubtless true that any one of several air-setting plastics might have been as satisfactory as the one used.

†A blend of phenol-modified alkyd resin and chlorinated hydrocarbons that is completely soluble in coal-tar solvents but insoluble in oil and short-oil varnishes.

Management Methods in Building Operation and Maintenance

MANAGEMENT METHODS in building operation and maintenance were discussed by Alexander J. Lewis, vice-president and operating manager of the Wacker Corp., formerly the Twenty Wacker Drive Building Corp., Chicago, in a recent issue of the Executives Service Bulletin published by the Policyholders Service Bureau of the Metropolitan Life Insurance Co.

The structure with which Mr. Lewis is concerned is the Civic Opera Building, Chicago, which has 740,000 sq ft available for business offices and 451,000 additional sq ft used as theaters, dressing rooms, rehearsal rooms, storage rooms, not including auditorium, lounges, and foyers.

Throughout the 45 story structure, service and maintenance is required for more than 1000 lavatories, 500 valves connected to water service lines, 5000 radiators with their valves and traps, 121 steam risers to supply radiators, and 91 steam return risers, 436 electric motors, 37 generators, 536 elevator doors and 38 elevators, and more than 50 ventilating machines to supply and exhaust air. Other equipment includes steam generating, house pumps, fire pumps, and many auxiliaries.

In planning such a structure with its diversified operating problems and business demands, there were many items to be considered from an economical and operating standpoint, items not as a general rule given thought or consideration during the preparation of plans and specifications, but nevertheless important to those who live with the building long after completion, according to Mr. Lewis. It is the duty of the engineer in charge of construction for the owners to think and work fast in order to make the necessary changes as construction work progresses in order to avoid "extras." It cannot be emphasized too strongly that the engineer should be the owners' representative who, upon completion of the building, will be given responsibility for its operating costs, he says.

Special Steam Lines and Valves

As an illustration, in this building there are clubs, restaurants, theaters, offices, and stores, all demanding service at different periods of the day and night, service which should be provided at costs within the range of other typical properties. In this connection, engineering skill has a great opportunity for demonstration, says Mr. Lewis. Special steam lines, shutoff valves, automatic controls, and electric circuits must be installed and other changes made so that services may be rendered only to the zones and sections as required. The savings effected by this method of planning have been tremendous.

Three hundred employees are at work in the operation of this building. They represent skilled and unskilled labor, and, regardless of the degree of proficiency or of the extent of their experience, much time and effort must be given to their training, and this has been done through a comprehensive educational program.

It is considered extremely important, says Mr. Lewis, to have all the mechanical trades in the building associated as one group, the reason being that in their daily work these specialists are more or less in contact on maintenance, repair work, and construction work. Valuable points brought out in connection with the job of the engineer are also applicable to the plumber, the steamfitter, the electrician, and vice versa. The engineers are instructed in good operating practices and in the proper action to take in emergencies. As a matter of fact, all departments or groups are drilled in their participation in the case of fires and floods.

In the training procedure, use is made of the classroom technique in the interest of closer instruction and for the sake of the valuable discussion in which all may join. In all class training, no matter how specialized, accident prevention is a most important consideration.

Group meetings at the outset were held at frequent intervals until the best possible results were obtained, after which refresher meetings were held as the need indicated. The discussions brought out many obstacles unseen by management, yet easy to correct. The class system of training, regardless of the nature of the work done by the trainees, pays dividends to both employee and employer. All join together in friendly discussions that create the kind of relationship which promotes better work and greater cooperation. It is emphasized that "A job worth doing is worth doing well."

A SMOKE ELIMINATION Program THAT WORKS

Raymond R. Tucker Analyzes St. Louis Smoke Ordinances

LEGISLATION ALONE will not clarify the air. Education alone will not clarify it. Furthermore, education and legislation together will not give a clear atmosphere. Education presupposes a desire to learn, and legislation presupposes an impartial, efficient, and vigorous enforcement program. For smoke elimination to be effective, there must also be an overwhelming desire upon the part of the citizens to rid the city of smoke, and an administration with the necessary courage to transform this desire into an actuality. These ingredients—appropriate legislation, education, aroused citizens, and a fearless political administration—can solve any smoke problem.

Eight ordinances were passed to complete the program in the city of St. Louis. They consisted for the most part of amendments to the original 1937 ordinance. When the final ordinances were passed, seven of the original ones were combined into three.

The ordinance prohibiting the sale in the city of St. Louis of high volatile coal over 6 in. in size was never put into effect. This ordinance was requested when high volatile fuel was permitted to be used in hand-fired furnaces. St. Louis at that time was one of the largest lump markets in the world, and it was not unusual to deliver to coal customers lumps 36 to 48 in. in diameter. This was done even though the coal industry advocated proper firing as the solution for the smoke problem; instructions on the proper method of firing these lumps were not supplied (a sledge hammer would have had to be provided with the instructions!). This ordinance was repealed when the final ordinance was passed in 1940.

Locking the Barn Before the Horse Is Stolen

The smoke abatement program as conceived and executed was based upon the fundamental principle that all fuel and equipment being used, and all equipment installed, repaired, or remodeled, must be controlled by the division of smoke regulation. It was the intention of the division to lock the barn before the horse was stolen.

There are three basic ordinances which control the St. Louis program—the smoke ordinance itself, the fuel ordinance, and the personnel ordinance.

The smoke ordinance contains many provisions which are common to other ordinances of a similar character. In addition, however, there are many unique features which give the division of smoke regulation the necessary control. It is suggested that, when any ordinance of this character is passed, the council or board of aldermen be specific as to their intent in its passage. This was forcibly brought to the attention of the division of smoke regulation in the preliminary work which it did between 1937 and 1940. The St. Louis ordinance is prefaced by a resolution passed by the board of aldermen which specifically states that it is the intent of the board to safeguard the health and welfare of the citizens. This leaves no doubt in the mind of the public as to what the board's intention was, and as a health measure the police powers of the city are very comprehensive. It also eliminates many tedious hours in court as legal counsel argue as to what the intent of the ordinance may be.

It is essential that dense smoke be defined for the purpose of enforcement, although a case is recalled wherein the judge ruled that there shall be no subtle distinction as to what "dense" smoke is, but smoke shall be considered "dense" if in the opinion of the average individual it is considered "dense." In defining dense smoke, it is desirable to specify the means by which it shall be determined. There are many ways of metering the density of smoke; very few, however, are practical for an inspector to use. The St. Louis ordinance made the Ringelmann chart, as published by the Bureau of Mines, a standard because it was practical.

It is suggested that the judge of the court in which cases are to be tried be acquainted with the use of this chart as well as its background; this will eliminate misunderstanding. Dense smoke is defined in the ordinance as smoke whose density is equal to or greater than No. 2 of the Ringelmann chart.

The St. Louis ordinance prohibits the emission of smoke at all times, except during those periods when a new fire is being kindled or the fire is being cleaned. Nine minutes of No. 2, or six minutes in excess of No. 2 density in any one hour are considered a violation for stationary plants. One continuous minute of No. 2, or greater, in any one hour is considered to be a violation for any locomotive ready for service or in service. The jacks of roundhouses are considered as stationary plants. The previous ordinance had considered six minutes of No. 3 on the Ringelmann chart in any one hour as a violation. Under these conditions it was possible to have four to five minutes of No. 3 and an additional 10 to 15 minutes, or more, of No. 2 smoke when starting or cleaning a fire. To

eliminate this condition, the two foregoing limitations were placed upon the operators.

Fly Ash May Be a Nuisance

Although smoke is a very definite nuisance, fly ash may become one, too. Grain sizes as well as quantity of fly ash are pertinent to its elimination. The St. Louis ordinance definitely limits the amount of fly ash that can be discharged from plants burning fuel in suspension or partially in suspension. It should go further and limit the discharge of all solid particles. St. Louis was one of the first cities to prescribe the grain loading or the amount of fly ash in each cubic foot of stack gases, as well as grain size. The ordinance specifies that the discharge gases cannot contain more than 750 grains of fly ash per 1000 cubic feet, and that not more than 200 grains of this 750 may exceed 40 microns in size. This grain loading is to be measured under definite conditions, viz., 50 per cent excess air at full load. It is further stated that the grain loading shall be measured by the method outlined in the tentative test code for dust separating apparatus of the American Society of Mechanical Engineers. This grain loading, although obsolete at the present, was determined by the development of the art of dust collecting at the time the ordinance was passed.

It was not desired to make requirements such that only one type of apparatus could be used, so the guarantees of many of the better types of apparatus were considered —and from these guarantees this standard was established, which revealed the development of the art to that date. The present ordinance should be amended to take advantage of the advances which have been made in the past five years. This provision, as far as dust is concerned, does not eliminate the nuisance at its source. However, it would be impractical to endeavor to prevent the erection of a plant burning fuel in suspension or partially in suspension, if it is possible for the plant to operate without creating a nuisance. To insure this, the St. Louis ordinance does require all such plants to be equipped with dust collecting apparatus approved by the division of smoke regulation. This gives some measure of control.

Striking at the Heart of the Problem

The two preceding provisions of the smoke ordinance are essential for enforcement. They do not, however, aid in the elimination of the source of the smoke evil. The provision in the ordinance requiring the preparation of all high volatile coal for use in mechanical fuel burning equipment, and the requirement that all hand-fired equipment shall use a smokeless fuel, strike at the heart of the problem.

The ordinance requires that all fuel 2 in. and under in size, which contains an ash content in excess of 12 per cent and a sulphur content in excess of 2 per cent, must be washed or cleaned until the ash content does not exceed 12 per cent on a dry basis. This requirement not only reduced the ash content of the fuel but it materially reduced the sulphur content. No limitations were placed upon the final sulphur content because it could not be predicted. Washing only removes the pyritic sulphur and not the organic sulphur. Theoretically, a 40 to 60 per cent reduction in sulphur content of the face samples could be expected because the fuel contained 40 to 60 per cent pyritic sulphur. Actually, only 25 per cent was claimed.

The sulphur content of the coal being received in St. Louis was about 5 to 7 per cent, while the average sulphur content of the face sample analyses showed 3.25 to 3.5 per cent, the reason being that the pyritic sulphur was not being picked from the fuel. Washing would remove this sulphur; consequently the actual reduction in sulphur was far greater than indicated above. High sulphur coals should be avoided if pure air is desired. L. C. McCabe, associate geologist of the state of Illinois, states,* "It would be difficult to overestimate the value to a municipality of the effective reduction of fly ash and sulphur fumes which can be brought about by the use of clean coal. Any effort directed toward reduction of atmospheric pollution by fly ash and sulphur fumes through the use of better prepared fuel should be encouraged because it is based on sound scientific premises."

The washing provision of the ordinance protected the mechanical fuel burning equipment by eliminating from the market coals excessively high in ash and sulphur and low fusion point of ash. This was essential if the mechanical fuel burning equipment was to receive

THIS REVIEW of the three ordinances governing the operation and enforcement of the smoke program in St. Louis clearly demonstrates the regulation of all factors pertinent to the elimination of smoke at its sources. The system of installation permits and certificates of operation determines the physical characteristics of the plant. The licensing of the fuel dealers governs the type and character of fuel that is used. No one is exempt under the terms of the ordinances—the basket peddler as well as the coal merchant, the side-arm hot water heater as well as the industrial furnace, the domestic user as well as the railroads—all must conform. So it must be if success is to crown smoke abatement efforts. . . . Professor Tucker is well qualified to write on smoke elimination, for he has been intimately concerned with the program in St. Louis. Now head of the department of mechanical engineering at Washington University in that city, he was smoke commissioner of St. Louis from 1937 to 1942. He is a member of the American Society of Mechanical Engineers. In addition to many talks on smoke elimination before various groups in St. Louis, he has also discussed the program at engineering meetings in cities where it is hoped to inaugurate similar projects.

*Transactions, ASME, January 1939. Some Problems Related to Preparation of Coal.

No one is exempt from the ordinances described

wide and satisfactory acceptance in this market. The requirement specifying that fuels contain 23 per cent or less volatile matter on a dry basis controlled those hand-firing their furnaces. It was realized that per cent of volatile is not necessarily a true index of the smoke-making characteristics of every fuel. A comparison of Illinois coal and the eastern coals showed that in this particular case a definite correlation existed between per cent volatile and quantity of smoke. Ordinarily the eastern fuels are low in ash and sulphur. Recently there has been shipped into St. Louis fuel whose ash content is excessive, even though the volatile content is low. This is permissible because the ordinance does not limit the ash content of low volatile fuel. The present ordinance should be amended to specify the volatile content on an ash and moisture-free basis rather than a dry basis, thus eliminating the possibility of reducing the volatile content by the addition of inert refuse.

It was thought the passage of this ordinance would stimulate the development of smokeless fuel processes. To meet this condition, provisions were made in the ordinance to allow the products of such processes to be accepted for use and consumption in St. Louis provided they possessed the same smoke-making characteristics as a fuel containing 23 per cent or less volatile matter on a dry basis. The smoke commissioner prescribes the tests to determine their acceptability, and the petitioner must pay the expense of such tests to a mutually acceptable consultant. Only one such product has been accepted under these condition, a processed briquet.

Installation of Fuel Burning Equipment

As originally stated, it was essential that the installation of all fuel burning equipment, as well as fuel, be under the absolute jurisdiction of the division of smoke regulation. In addition, control over any reconstruction, remodeling, or repair work on combustion equipment is also essential. This control should not be limited. St. Louis was the first city to make this requirement all-encompassing; the ordinance does not exempt any user of fuel, domestic or otherwise.

Faulty installation of new equipment, or equipment improperly sized, will cause difficulty in the domestic as well as the industrial plant. It will not give satisfaction and it will cause the owner to be cited for smoke violations, thus destroying the morale of those desiring to cooperate. Installations of this type are usually the result of ignorance or unethical competition. Such were the conditions in St. Louis previous to the passage of the ordinance in 1937. Bids on the same job varied over a wide margin, sometimes the low bid being half that of the high one. Fuel burning equipment was installed without giving due regard to the combustion volume, load, clear height, controls, etc. The direct result of this was chaos, and the legitimate firms were seriously handicapped. Furthermore, there were many plants that were overloaded and obsolete. When repair work was necessary, nothing was done to eliminate the obviously incorrect conditions.

These conditions were a prolific source of smoke. The ordinance recognized this and set up a system of installation permits and certificates which gave the division of smoke regulation the necessary control. It specifically requires that complete plans and specifications of all installations must be submitted to the division of smoke regulation before the installation is made. There is a further requirement that no repair work, or remodeling, or reconstruction can take place unless the commissioner of smoke regulation is so notified and the installation permit taken out for the work being contemplated. The ordinance goes further and requires that the building commissioner submit all plans for new buildings to the division of smoke regulation in order that the fuel burning equipment and auxiliaries may be checked before a building permit is issued.

When the installation permit has been issued, work is permitted to proceed; however, the apparatus is not to be used until an inspection has been made by the division of smoke regulation. The inspection consists in checking the installation in order to see whether or not it is in accord with the plans and specifications originally submitted. If the installation passes this inspection, a certificate of operation is issued to the owner authorizing him to use the plant. The issuance of these certificates of operation in no way implies that the owner of the equipment is free from supervision and the restrictions set forth regarding the emission of dense smoke. It is by this means that the

division of smoke regulation oversees all work done on fuel and refuse burning equipment within the city of St. Louis, and demands conformance to basic engineering principles. One of the sources of trouble is thus eliminated—the equipment at least is in such condition that with ordinary care and attention it may operate in such a manner as to conform to the provisions of the ordinance.

Reporting Sales of Fuel Burning Equipment

As one reads of these provisions, he is probably impressed by the magnitude of the task of supervising work of this character. Furthermore, he no doubt is under the impression that a provision of this character is a mere gesture unless all such equipment comes within the purview of the division of smoke regulation. For this reason, there has been incorporated in the ordinance a provision which requires all firms and corporations engaged in the business of selling refuse or fuel burning devices for production of heat or power, to report to the commissioner of smoke regulation the sale of each article to be installed, giving the name of the purchaser as well as the address. This report must be made in writing within seven days after the sale. To insure compliance with this provision, the division of smoke regulation has been granted the privilege of entering the premises of such sellers, at all reasonable hours, to examine all books and papers pertaining to such sales. With very few exceptions, a meticulous record of sales has been submitted to the division of smoke regulation. As an additional aid to enforcement of this provision, sellers of equipment often report by phone sales that they lost; that is, when a sale had been lost the loser usually calls the division of smoke regulation to inquire as to whether or not a permit had been requested for such installation.

It has been the policy in many communities to exclude the railroads from the requirements of smoke ordinances. This should not be done. The railroads contribute their share to the pollution of the atmosphere and should be subject to control. The St. Louis ordinance requires all railroads operating in the environs of the city to use either diesels, low volatile fuel, oil, or electric locomotives. Mechanical fuel burning equipment may be used provided it conforms to the ordinance definition of such equipment, and this definition requires automatic controls. A distinction is made in the case of road engines or those operating on regular runs. Road engines, however, are required to meet the provisions of the ordinance with reference to the emission of dense smoke.

Smoke Regulation Division Can Seal Equipment

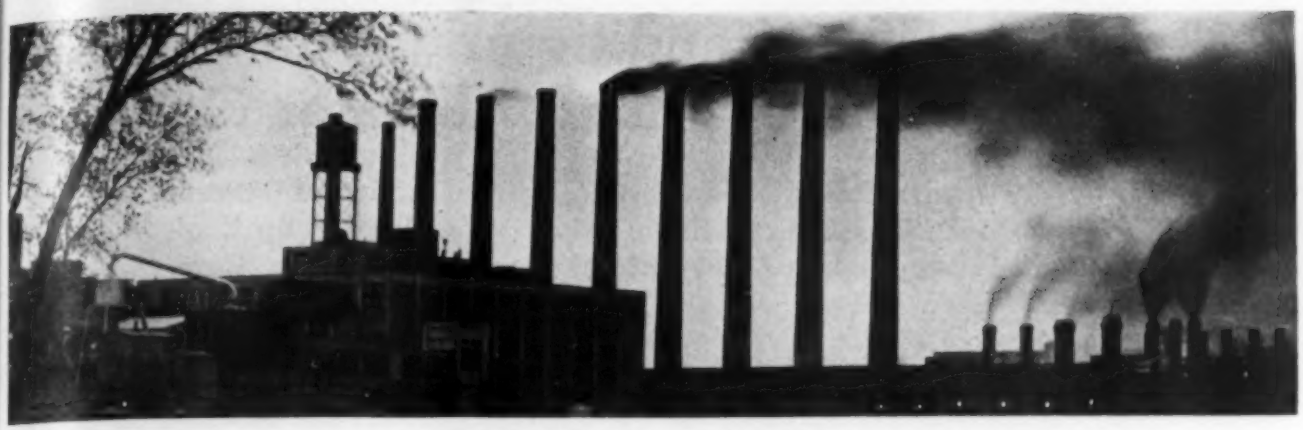
There has been presented so far some of the means which have been used to control the emission of dense smoke at its source. The enforcement of these sections of the ordinance, however, offers an additional problem, and the success of the program depends upon the ability of the division of smoke regulation to enforce these provisions. When the ordinance was drawn up it was realized that, unless the division of smoke regulation had sufficient power delegated to it to enforce the requirements, the program would fail. There was therefore incorporated in the ordinance a section which permits the division of smoke regulation to seal fuel burning apparatus if compliance is not had with the provisions of the ordinance regulating the issuance of permits and certificates, and in addition the same authority was granted if the owner of the equipment had three or more violations recorded against him during any 12 month period. Before such sealing can take place, it is necessary for the commissioner of smoke regulation to hold a hearing in order to give the owner of such equipment an opportunity to show cause why the equipment should not be sealed. This authority to seal is legal, and has been so declared by the U. S. Supreme Court in the year 1916 in the case of the Northwestern Laundry vs. the City of Des Moines, which upheld the sealing of equipment creating a nuisance. The court ruled: "Nor is there any valid federal constitutional objection in the fact that the regulation may require the discontinuance of the use of property, or subject the occupant to large expense in complying with the terms of the law or ordinance."

An additional provision of this section of the ordinance provides that notice of such hearing can be given by mail directed to the last known address, or by posting a notice on or near the premises on which violation occurred. This provision was incorporated in the ordinance to avoid the difficulty of service. The experience of the division in the past had been that it was a practice of real estate owners to use straw parties, and that the owner of record was not necessarily the rightful owner. Furthermore, excuses were presented that notification of such sealing had not been received. Posting the property eliminates these excuses.

It would appear that the commissioner of smoke regulation was given rather arbitrary powers and no recourse could be had unless his decisions were adjudicated by courts. This would cause unnecessary expense if the commissioner failed to exercise commonsense. To avoid taking every so-called unreasonable decision the commissioner

* * *

USE THIS ARTICLE and the others to follow on smoke elimination in St. Louis in your own community to inform city officials and your fellow-citizens on what can be done, and how it was done in this particular case. Abating smoke—of vital concern and advantage to all—is an engineering job.



Smoke elimination is an engineering job

might make to the courts, an appeal board was created which permits any person aggrieved by any decision of the smoke commissioner to appeal such decision to this board. The appeal board then sets a time for a hearing for such complaints, and gives notice by mail to the interested parties. The appeal board, after such hearing, may vary or modify the application of any of the regulations or provisions of this ordinance so that the spirit of the ordinance may be observed, the public welfare and safety secured, and substantial justice done. A check is thus provided on the activities of the commissioner.

Solid Fuel Ordinance

The character of the fuel, its method of preparation, and its smoke-making characteristics, are, of course, of vital interest to those advocating any smoke program. Fuel should be provided so that, with reasonable care and attention, conformity to any smoke ordinance may be had.

This theory is contrary to the oft-expressed thought that no restrictions should be placed on the type of coal used. It has been advocated that the consumer of the fuel is solely responsible, and that in the event he violates he should be prosecuted. The history of smoke abatement does not produce one example wherein widespread prosecutions have eliminated smoke.

To insure that the provisions of the smoke ordinance specifying the type of fuel shall be enforced, a companion ordinance was passed which is commonly designated the "solid fuel ordinance." This ordinance contains a provision which requires every person engaged in the handling of solid fuel to obtain a permit from the smoke commissioner, and file with this permit a $1000 surety bond. This bond is conditioned to hold harmless any person or purchaser involved in any transaction with the permittee pertaining to the importing, producing, and hauling of solid fuel for consumption in St. Louis. This permit runs for a period of one year before renewal. In the event the holder of this permit is convicted of violation of any of the ordinances of the city of St. Louis concerning the use, sale, distribution, or consumption of solid fuel, his permit can be revoked by the board of public service. Also, if the commissioner finds the continuation of any permit not consistent with the public welfare, he can revoke such permit with the approval of the board of public service. Thus, control is had over the fuel dealers within the city, and instead of obtaining violations against many thousands of stacks, it is only necessary to check up on the activities of approximately 1500 fuel dealers to see that they supply a fuel conforming to the requirements of the smoke ordinance.

The Personnel Ordinance

The administration of these ordinances requires trained personnel. The commissioner of smoke regulation should be an engineer, qualified by training and experience to handle the multifarious problems that are presented to him. He should be not only technically sound but should also possess the temperament and experience necessary to enlist the cooperation of various civic organizations and others interested in the abatement of smoke. Too, he should have a definite sense of public relations. The inspectors should also possess these characteristics in a lesser degree.

The manner in which the commissioner and inspectors were chosen was described in the September HPAC. It is desirable that the commissioner of smoke regulation be responsible to the mayor alone; the line of authority should not go through other appointed officials. (This may not be possible in some communities because of already existing charters or state laws.) There should also be lodged in the commissioner the authority to appoint his own personnel, for he is then solely responsible for their character and ability.

A personnel ordinance of this type was passed in St. Louis. It was considered as a separate and distinct subject, and was not an integral part of the basic smoke ordinance; this was considered to be a sound policy because it obviated the possibility of future attacks upon the smoke ordinance. The separate personnel ordinance permits amendment while leaving the basic ordinance inviolate.

[This is the second of Professor Tucker's articles on this subject for HPAC. Others will follow.]

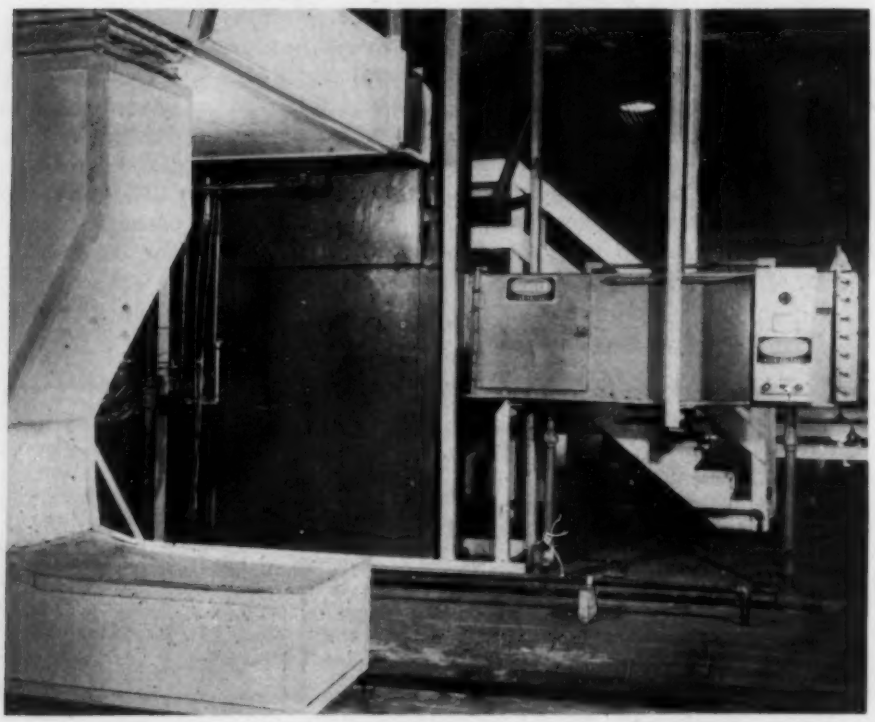
Why don't you contribute a "practical pointer" on operation, maintenance, repair, alteration, or extension of a heating, piping, or air conditioning system for publication in HPAC? Regular publication rates are paid for them. Address The Editor, Heating, Piping & Air Conditioning, 6 N. Michigan Ave., Chicago 2.

Packaged Air Conditioning Unit Holds Uniform Temperature for Master Gages

Trend Toward Closer Fits Requires Gage Calibration at Uniform Conditions, Says E. Rasmussen, Heating and Ventilating Engineer, Factory Service Div. of Westinghouse Electric Corp.

IN ORDER TO manufacture to the close tolerances that are being designed into industrial products, instruments used to measure or gage parts must be calibrated with an extreme accuracy. The temperature of 68 F (20 C) has been adopted as standard for gages by standardizing bodies of practically all the industrial nations of the globe. The reasons for choosing it as the standard temperature for gages include the facts that it was already in wide use for metric gages, it is expressed as a whole number on both the Fahrenheit and Centigrade scales, and it is a reasonable room temperature fairly easy to obtain and maintain almost anywhere.

Overall view of the master gage laboratory



All ductwork, the refrigerating system, and air cleaning equipment are hung by angle irons from overhead beams to avoid transmitting vibration to the room. Note the electrostatic air cleaner in the foreground, and the canvas joint in the ductwork at upper left

Since the difference in coefficients of thermal expansion of various materials used for both the gages and the product gaged may result in appreciable error, there has come into being an increasing number of master gage laboratories to which gages can be brought for checking in a clean, constant-temperature atmosphere. One such laboratory, at the East Pittsburgh works of Westinghouse, utilizes "packaged" air conditioning apparatus to maintain the temperature at 68 F ± ½ F dry bulb the year around, and is so constructed that vibration is eliminated.

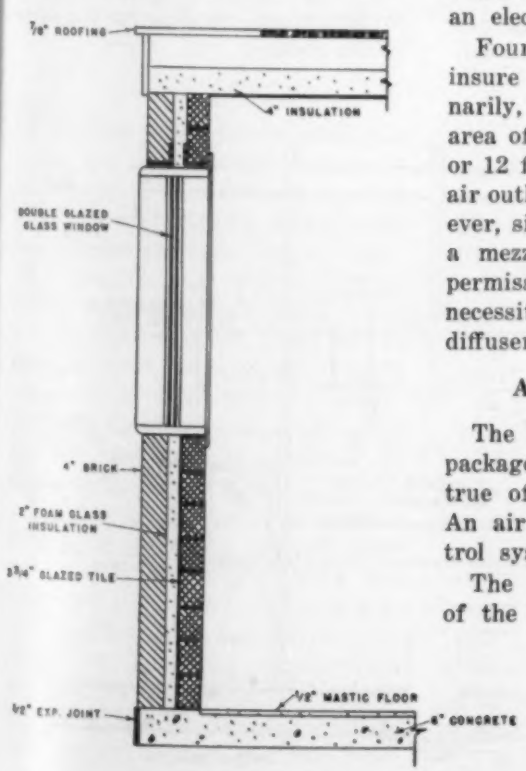
Overall size of the room is 30 by 32 ft, which is sufficient to handle work from all divisions. Situated in one of the main production aisles convenient to the tool department, it is isolated from the main floor by a ½ in. expansion joint filled with a tar based compound, to eliminate any vibration that might be transmitted from fabricating machinery. In addition, all air conditioning apparatus and accompanying ductwork is hung by angle iron from overhead beams over the roof of the room. Canvas joints are used to connect the galvanized iron ducts with the room inlet and outlet.

Because of the necessity for holding the temperature to such close limits, the outer wall, of 4 in. brick, is separated from the inner glazed-tile block wall by 2 in. of foam glass insulation. The win-

dows, of which there are two, are double glazed. The ceiling is composed of ½ in. of fiber board, 4 in. of rock wool insulation, and is capped with a 1 in. wooden floor. Thus, the entire construction keeps cooling losses at a minimum.

Being placed inside a heated building, the laboratory is not subjected to the wide temperature cyclings of the seasons. However, because of this, cooling must be provided throughout the year. During the summer months the refrigerating compressor is run continuously and the room temperature is controlled by passing discharge water from the condenser through a reheat coil in the air supply duct. During the winter months the compressor is shut down, and the room temperature is controlled by using the reheat coil as a cooling coil and using city water as the cooling medium.

The cooling load was calculated as 58,000 Btu per hr with outside conditions of 90 F dry bulb and 80 F wet bulb, and inside conditions of 68 F dry bulb and 45 per cent relative humidity. To maintain this temperature, a standard packaged 5 ton unit—complete with compressor, evaporator, condenser, fan, and filters—was selected. The compressor is a four cylinder, refrigerant cooled, hermetically sealed unit; the evaporator consists of four rows of ⅝ in. copper tubing with a 3.93 sq ft face area; the reheat coil has four rows (staggered) of tubing with a face area of 3.2 sq ft. The fan is driven by an adjustable pitch V-belt drive permitting a variation in fan speed from 690 to 935 rpm.



Typical section showing the wall, window, and roof construction

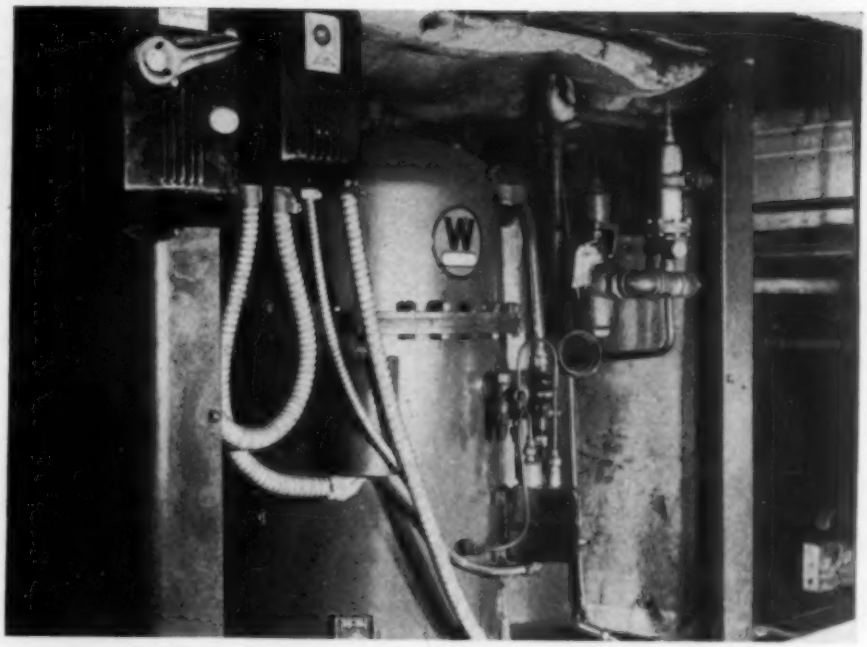
Air capacity of the system is estimated at 2130 cfm, of which 1880 cfm is recirculated and 250 cfm is make up air. Glass throwaway filters are used in the duct to cleanse the recirculated air, but all outside make up air passes through an electrostatic air cleaner.

Four air diffusers are used to insure draftless distribution. Ordinarily, a temperature controlled area of this sort should have a 10 or 12 ft ceiling, in which case two air outlets would be adequate. However, since the gage room is under a mezzanine floor, the maximum permissible ceiling height of 8 ft necessitated the installation of four diffusers.

Air Operated Controls

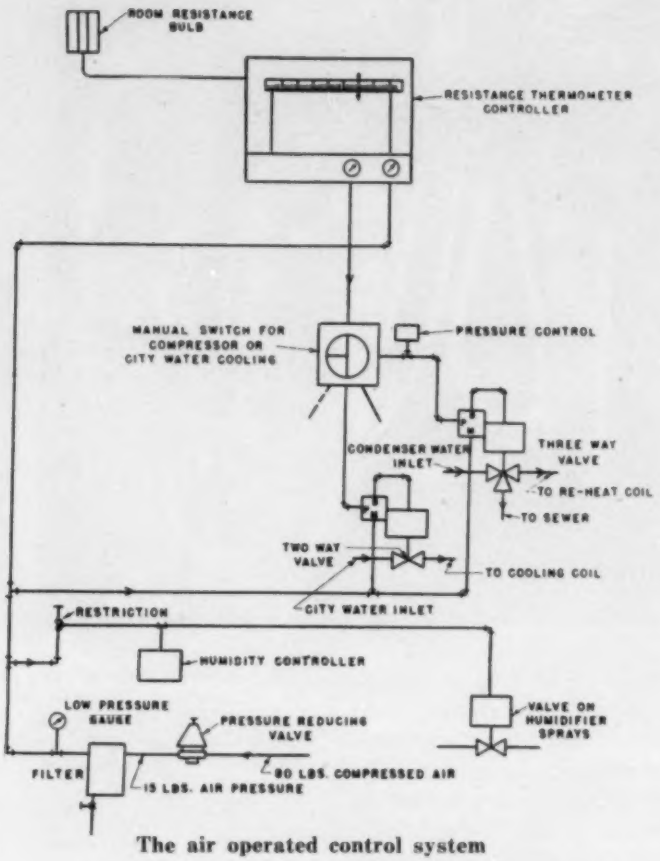
The refrigerating system is a packaged unit, but the converse is true of the temperature controls. An air operated temperature control system was selected.

The control equipment consists of the following: resistance ther-



The compactness of the compressor is illustrated here. A packaged cabinet containing compressor, condenser, evaporator, and blowers handles the cooling load

The panel board contains all the instruments, including temperature and humidity recorders, a master thermostat, and humidistat, and the manual switch for compressor operation or city water cooling



The air operated control system

mometer recording controller with a range of 60 to 80 F; room temperature bulb; humidity controller; selector switch; ¾ in. two-way air operated valve; ¾ in. three-way operated mixing valve; ½ in. air operated water valve for humidity; and a pressure control.

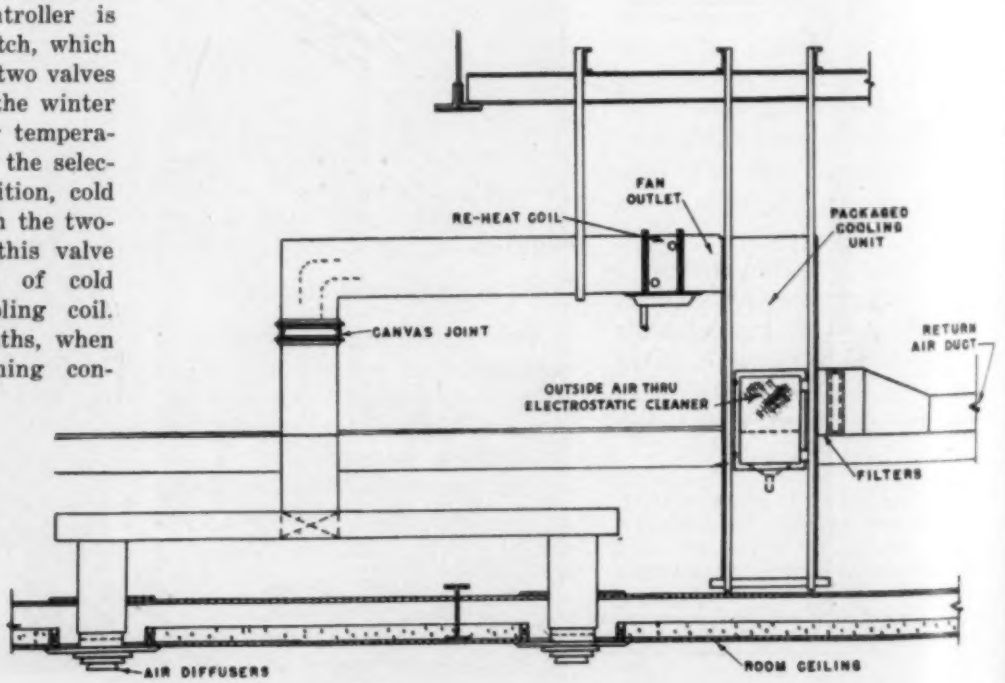
The room temperature bulb is wired to the resistance thermometer controller; this controller is piped to the selector switch, which determines which of the two valves are to be used. During the winter months, when city water temperature permits, by turning the selector switch to No. 1 position, cold city water passes through the two-way modulating valve; this valve determines the amount of cold water entering the cooling coil. During the summer months, when the compressor is running constantly, the selector switch is turned to No. 2 position. The two-way valve will then be in a tight closed position and the controller will position the three-way mixing valve which determines the amount of hot condenser water passing through the cooling coil now functioning as a reheat coil.

SUPPORT THE VICTORY LOAN!

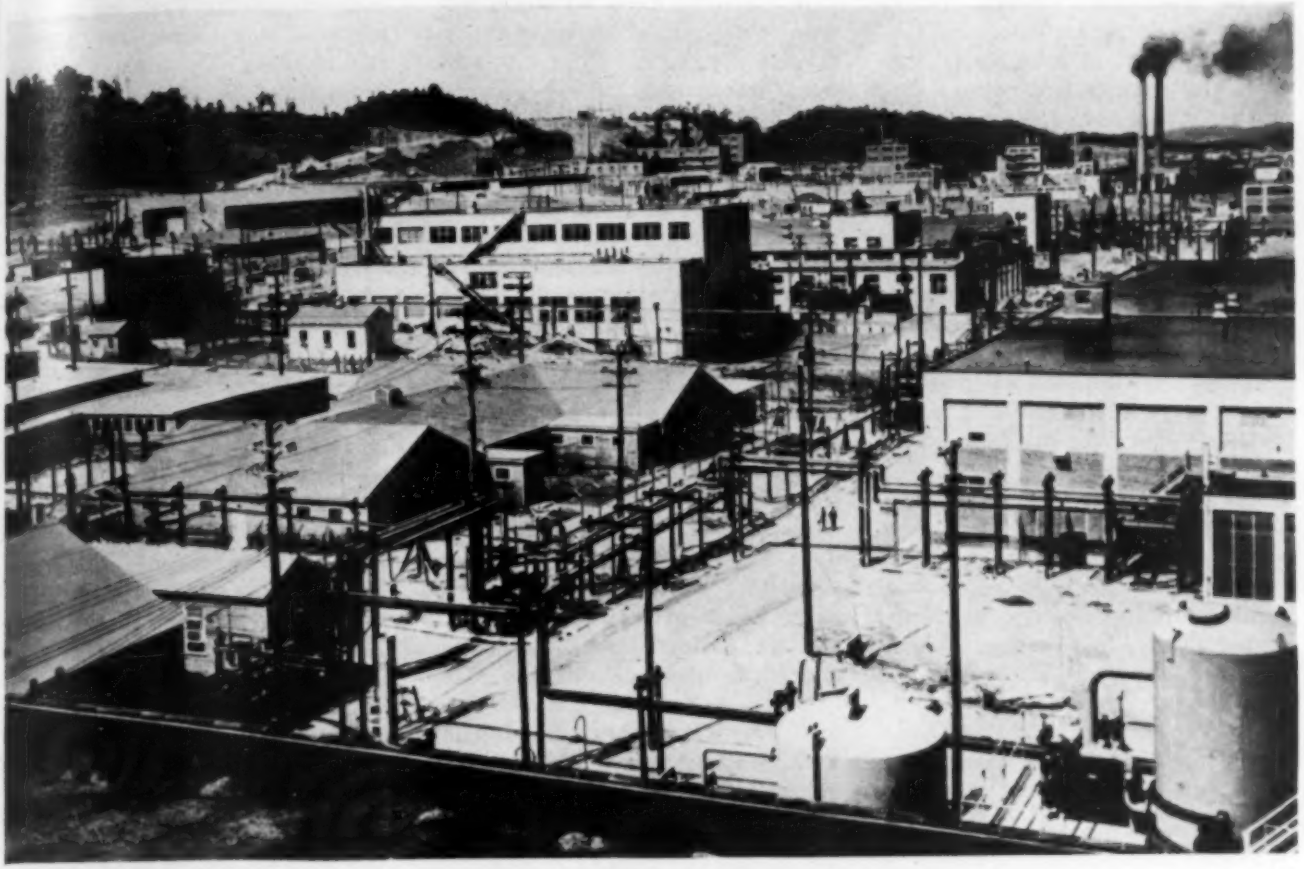
Since this is a modulating or proportioning type valve, there may be times when a portion of the condenser water is entering the reheat coil and a portion is discharged to the sewer.

At 15 psi air pressure in the controller, all condenser water is passed to the sewer; at 8 psi air pressure, all the condenser water is passed through the reheat coil. However, there may be times during the night when the cooling load is so light that with the compressor running the reheat from the condenser water is not sufficient to hold the temperature at 68 F. The temperature may drop to 67¾ F. The air pressure from the controller will drop below 8 psi; the pressure control will then stop the compressor. As soon as the temperature starts to rise, the pressure control will automatically start the compressor again.

The humidity controller positions the air operated water valve on the humidity spray nozzles so as to maintain a 40 per cent relative humidity in the room during the winter months. A humidity recorder records the relative humidity in the room.



Room elevation sketch showing the ductwork and method of hanging the refrigerating unit



One of the production areas at Oak Ridge

Heating, Piping, and Air Conditioning at OAK RIDGE

By J. K. Fairbairn

THE WORLD now knows what Oak Ridge has been making during its short life, but that's all it does know and that's all it's probably going to know for some time to come. This makes any description of piping here a difficult thing, since any piping man can come fairly close to what a plant does if he knows what the pipes are doing. This will have to serve as an excuse for the very general character of this article.

The War Department has released several photographs of the town and also of the plant. Both the town and the plant have large central stations, with the distribution above ground, either on pole lines or piers. The steam in the town is used only for the central facilities, such as the cafeterias, the town hall, the main administration building, and the commercial buildings. Practically all other buildings have individual heating plants, of various design, reflecting (presumably) individual preference, design requirements, and the exigencies of supply. When these jobs were done, the designer took what he could.

In general, the buildings served from the central station in the town are heated by steam radiators, fed from the high pressure main through a reducing valve into a low pressure system. The dormitories for single men and single women have individual heating plants, most of which have hand fired cast iron sectional boilers, using steam to supply a blast coil. The heat distribution is by means of air.

The family residences are of various types. There is a so-called "permanent" type, which shows what mass production might lead to in the housing field. The walls are prefabricated panels made up of cement-asbestos board and insulation. I might say it was intensely interesting to watch the town rising from the hills and dales here, for the job was broken down skillfully, and the progress of the work was amazing. First came the masons, laying up the cement block foundation, and erecting the fireplace and chimney. Rough carpentry came next, and a panel frame of four-by-fours went up in no time, surmounted by prefabricated roof trusses. Next came the wall panels, roof, finish carpentry, and painting —and then you sent for your family.

The mechanical aspects of the houses are simple and adequate. Domestic hot water is by electricity. Plumbing fixtures are pottery, including the sink. Heating is by forced air, hand fired, with thermostatic control on the damper and bonnet control on the fan. The fan has a summer switch, which really comes in handy when the sun goes down. The houses are equipped with electric stoves and refrigerators. This all adds up to the reasonable necessities, and whereas the houses are not luxurious, it is astonishing that they are as good as they are.

The "permanent" houses are supplemented by "prefabs," which are smaller, cuter, and cheaper. They are also equipped with electric stoves and water heaters, and similar plumbing. The heating is done by hand fired circulator stoves. Both the prefabs and the permanents have one, two, and three bedrooms, and the houses were allocated strictly upon family requirements.

Besides these two types of housing, there are several others, from frame four-flats to trailers. In every case, the attempt was not toward luxury, but toward adequacy—to do the best possible in the least time, with the materials at hand. And if perchance the lumber has warped a bit as it has dried, well so has Hiroshima.

In the manufacturing area, things were done differently, although the same pressure was present. And perhaps things were a bit worse in the plant. After all, people have built houses before, and in large quantities; but nobody ever built one of these plants before.

Permanent Manufacturing Buildings

In general, the manufacturing buildings are permanent, of reinforced concrete with brick siding. Practically all other buildings are frame, with interior walls of processed wallboard, and partitions finished on one side only. There are several boiler plants in the area, distributing medium pressure steam through overhead lines. The steam is used for heating hot water, for heating both radiators and blast coils, and in a couple of cases for steam ejector refrigeration.

In the early days the steam system was enough to drive any operator to distraction. The dry days were not so bad, but whenever it rained every steam main evaporated enough rain to overload the boilers. This might convey some idea of the rush; steam was piped all over the area in bare pipes, because there was simply not enough time to cover the lines. Parts of the buildings were in operation before the construction men were out of the other parts, with all the attendant confusion inherent in such a situation. This lasted for a longer time than anybody liked, but soon a semblance of order emerged from the chaos, and the plant began to produce. Let it not be thought, however, that production was as simple as it sounds in that sentence. Just as one building got fairly well started, another one would be nearly ready, and the first would have to deliver personnel to the second. This continued as building after building came in. Each building was a training school as well as a production unit, with alternate periods of being overstaffed and understaffed.

A Maze of Piping

All of the foregoing seems to be preliminary to a discussion of heating, piping, and air conditioning, but the discussion must be so vague as to be uninteresting. If we look over the piping first, we can see mazes of it in almost every production building. The piping materials range from black steel through almost everything that a pipe was ever made of. These pipes carry practically every fluid that a pipe will hold; air at various pressures and temperatures, and at various humidities; raw and distilled water; oils and acids; oxygen and acetylene; and vacuum. It might be a new concept to heating men to see normal size pipes carrying steam, water, and air running alongside pipes twice as large carrying nothing at all.

Throughout the job, the pipe was welded wherever possible. And the welding specifications were tight. The best was none too good, and in some cases was not good enough. This plant has developed techniques from force of necessity which will prove to be advances in many of the industrial arts.

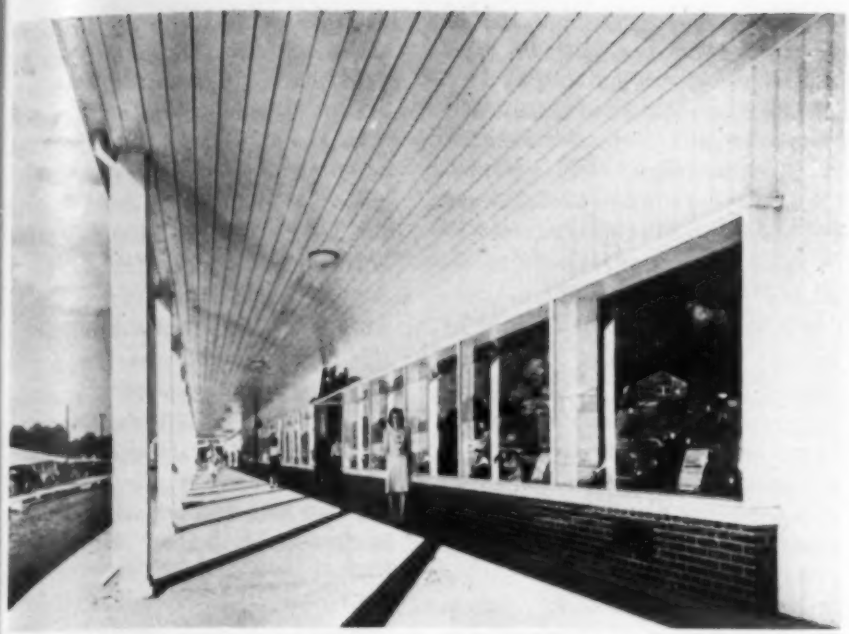
So much for the piping, and (from necessity) it isn't much.

AS IN SO MANY industrial processes, piping played a major part in the manufacture of atomic bombs at Oak Ridge, Tenn. It is of course impossible to say anything at all specific about the process at Oak Ridge, and very little about the piping, heating, or air conditioning services there. This general and brief article, written on the spot, does point out however that a lot of piping—of a wide variety of materials—is used, has a little to say about the types of heating systems, and gives a few paragraphs on ventilation and air conditioning.

Ventilation and Air Conditioning

Songs have been written about the fields of snowy white in sunny Tennessee. Over in this end of the state we don't get the snowy white, but we have the sunny, and plenty of it. And whereas Chicago or New York upon occasion can get hotter than Knoxville, we stay hot longer. And ventilation with hot, humid air is not especially conducive to comfort.

Every industrial process (outside a cold storage plant) produces some heat, and this plant is not unique in that respect. Since refrigeration equipment was almost impossible during the construction, practically the whole load of cooling fell upon the ventilation systems. Results were not good, but, all things considered, were better than could reasonably have been expected. The makeshift could have succeeded if it were not for the heavy consumption of energy per building, and its heavy concentration. As it is, ventilation carries the load very well until the outside temperature gets above 80 F, when it begins to break down. And when for days on end the thermometer hovers around 95, the industrial heat, the heat of the air, and the sun load combine to overload and frustrate the ventila-



Jackson Square, shopping center at Oak Ridge

tion, even though in some of the buildings it amounts to more than one million cfm. Cool nights, in the neighborhood of 70 deg, made the town comfortable, but could do little for the production buildings. It is a tribute to the personnel on the midnight shift that they stuck it out continuously, even though hot days in the town robbed them of their sleep.

With the exception of a few minor jobs (that is, minor in size), ventilation and air conditioning are synonymous. The exceptions are control jobs in laboratories to protect the laboratory process, and as such can be classed as industrial. Comfort conditioning for the personnel, executive or labor, is conspicuous by its absence. Industrial cooling is applied where needed, and it is done with the minimum equipment. Certain parts of the manufacturing equipment need cooling, which is accomplished by using oil, water, or air, as the occasion demands, for the convective medium. Depending on the level of temperature required, the heat is delivered to a forced draft cooling tower, a steam ejector, or a compressor.

From the standpoint of equipment, one is perfectly at home in this plant. On every hand are pumps, fans, blast coils, radiators, etc., with the old familiar names on them, as well as many that are not so familiar. Practically every manufacturer is represented here, and there are types of equipment in the line of pumps and fans that are not seen every day. If the plant is ever opened up to the public, no piping contractor or engineer should pass within 100 miles without a visit, for it will be well worth his while.

When all the reports on the project are in, there will be criticisms pro and con, and there will be room for both. This writer made the remark in 1943 that if it were not for his bills, he would consider it a privilege to work here for nothing; and in 1945 he feels the same way about it. The job cost lots of money. Money had much less value than time, however. When one considers that the first shovel hit the lot in May 1943, to erect a plant that nobody knew how to build, to produce in mass quantities a material that was a laboratory curiosity in 1939, perhaps great expenditures can be condoned. And it is a practical certainty that every GI in the Pacific (and his girl friend at home) will rejoice that he won't have to hit the beaches of Honshu.

Oak Ridge, as well as the whole Manhattan District, can say, "Mission accomplished."

Atomic Bomb Development Required Solving Pumping, Piping Problems

THE IMPORTANCE of the successful solution of piping and pumping problems and the development of new techniques is brought out in several paragraphs of the official report on the government atomic bomb project prepared by Henry DeWolf Smyth, chairman of the department of physics at Princeton, and consultant, Manhattan District, U. S. Engineers. The report, Atomic Energy for Military Purposes, has been published by the Princeton University Press.

In the chapter on the plutonium problem in February 1943, the possible materials and the corrosion problem are discussed:

"If water was to be used as coolant, it would have to be conveyed to the regions where heat was generated through channels of some sort. Since graphite pipes were not practical, some other kind of pipe would have to be used. But the choice of the material for the pipe, like the choice of all the materials to be used in the pile,* was limited by nuclear-physics considerations. The pipes must be made of some material whose absorption cross section for neutrons was not large enough to bring the value of k [the multiplication or reproduction factor] below unity. Furthermore, the pipes must be made of material which would not disintegrate under the heavy density of neutron and gamma radiation present in the pile. Finally, the pipes

* "Three ways of increasing the likelihood of a chain reaction have been mentioned [in the report]: use of a moderator; attainment of high purity of materials; use of special material, either U-235 or Pu. The three procedures are not mutually exclusive, and many schemes have been proposed for using small amounts of separated U-235 or Pu-239 in a lattice composed primarily of ordinary uranium or uranium oxide and of a moderator or two different moderators. Such proposed arrangements are usually called 'enriched piles.'"

must meet all ordinary requirements of cooling system pipes; they must not leak; they must not corrode; they must not warp.

"From the nuclear-physics point of view there were seven possible materials (Pb, Bi, Be, Al, Mg, Zn, Sn), none of which had high neutron-absorption cross sections. No beryllium tubing was available, and of all the other metals only aluminum was thought to be possible from a corrosion point of view. But it was by no means certain that aluminum would be satisfactory, and doubts about the corrosion of the aluminum pipe were not settled until the plant had actually operated for some time.

"While the choice of material for the piping was very difficult, similar choices—involving both nuclear-physics criteria and radiation-resistance criteria—had to be made for all other materials that were to be used in the pile. For example, the electric insulating materials to be used in any instruments buried in the pile must not disintegrate under the radiation. In certain instances where control or experimental probes had to be inserted and removed from the pile, the likelihood had to be borne in mind that the probes would become intensely radioactive as a result of their exposure in the pile and that the degree to which this would occur would depend on the material used."

In the chapter on diffusion separation, the report points out that "the pumps are to be operated under reduced pressure, must not leak, must not corrode, and must have as small a volume as possible. Many different types of centrifugal blower pumps and reciprocating pumps were tried. In one of the pumps for the larger stages, the impeller is driven through a coupling containing a very novel and ingenious type of seal. Another type of pump is completely enclosed, its centrifugal impeller and rotor being run from outside, by induction."

5000 New Products Resulting from Atomic Project, War's Gift to Peace

THE IMMEDIATE BENEFITS to American industry in new inventions, new and improved products, and procedures of manufacture resulting from the atomic bomb project were analyzed recently at a meeting held at the Biltmore Hotel, New York.

The keynote of the meeting was the premise, based on current estimates, that, as a result of the vast development work underlying the project, more than 5000 new products and procedures affecting all phases of American life are available to industry. These products and procedures now await only government release for commercial application.

Arranged on authorization of the War Department, the meeting included addresses by H. R. Austin, executive vice-president of the Kellogg Co., chemical engineers of Jersey City, N. J., and A. L. Baker, general manager of the Kellex Corp., a non-commercial industry-wide unit which engineered through to construction and operation one of the major plants of the atomic bomb project at Oak Ridge, Tenn.

The Kellex Corp., which included in its personnel a cross-section of the nation's scientific and engineering talent loaned for the war emergency by many companies, was formed for the purpose of developing procedure and designing equipment for volume production of uranium 235, an essential ingredient in the atomic bomb project. In this capacity the company had charge of the designing and engineering, and supervised construction of, the diffusion process plant at Oak Ridge.

According to a memorandum distributed at the meeting, this $2,000,000,000 project has resulted in many scientific developments, wholly apart from the fundamental factor of atomic power itself, which can be utilized immediately by a wide range of major American industries. These industries include petroleum refining, chemical processing, gas processing, manufacture of pressure and vacuum vessels, electrical, refrigeration, high vacuum, and industries employing corrosive chemicals. Benefits accruing to the medical profession and public health include: 1) a low cost, more abundant source of radioactivity; 2) improved protective methods for combating toxicity in industry; and 3) extension of cancer therapy.

The significance to industry of the work at Oak Ridge was reviewed by Mr. Baker who disclosed many facts which had been under a strict seal of secrecy for three years. Two major tangible assets accruing to industry were cited by the speaker as: 1) the experience gained in handling hitherto obscure products and the development of new ways of doing business "which cannot help but result in substantial cost-savings and increased quality throughout industry"; and 2) the prestige value of the accomplishment both internationally and in making for "closer integration of our own scientific world".

Mr. Baker said that most of the advantages are still necessarily under government ban of secrecy and he emphasized that the new developments totalled "not one or two, or an occasional isolated improvement, but literally *thousands*".

Mr. Baker added:

"What really happened was that here American skill created almost over-night a new industry. A totally new type of plant was built to employ totally new processes for the production of a totally new product. The principal building of the diffusion plant, six stories high and shaped like a U of U's, houses the largest chemico-physical continuous process in the world: a single process employing more pumps, more barriers, more power, more people, more instruments, more of every process-essential

than had ever been even thought of before."

Though detailed information concerning the thousands of new products and procedures has not yet been released, a cursory examination of the terrific problems and the solutions found portends much for the future of industry. For example, consider the following:

Corrosion

In the diffusion process for separating U-235 from natural uranium, it was imperative that no material in contact with the process gas react with it since such corrosion would lead not only to plugging of the microscopic pores of the diffusion barrier and various mechanical failures but also to absorption (i. e., virtual disappearance) of enriched U-235 isotope. Obviously, therefore, standard type valves and piping could not be used; instead, new methods of pretreating metal surfaces against corrosion were worked out, new coolants, piping, new type heat exchangers, lubricants, pumps and packing were developed.

Hydrogen fluoride is an important isomerization and alkylation catalyst in petroleum refining as well as an important raw material in the production of aluminum and refrigerants. It is, however, so highly active and dangerous that industry has not yet capitalized on many of its potentialities. Its handling may now be made safer and simpler without excessive maintenance costs.

Other important starting materials for a host of industrial products such as sulfur dioxide, hydrogen chloride and the mineral acids (sulfuric, nitric and phosphoric) have all presented severe problems of transfer and corrosion with particular emphasis on valve lubricants and pump packings. These difficulties can be greatly simplified by application of the knowledge gained.

Pumps

The story on pumps, the heart of the process and one of its most difficult problems, is particularly interesting and applicable to modern industry. Thousands of pumps operating under reduced pressure at Oak Ridge created problems in vacuum technique on an unheard of scale. Other thousands operated at nominal pressures. But regardless of the type or service none could leak or corrode and all had to have as small a volume as possible. Many different types of centrifugal blower pumps and sylphon-sealed reciprocating pumps were tried out and new types developed. For example, in one of the pumps for the larger stages the impeller was driven through a coupling containing a very novel and ingenious new seal. Another type of pump was completely enclosed, its centrifugal impeller and rotor being run from the outside by induction.

Top flight pump designers from leading manufacturers in this country collaborated in research and succeeded to a remarkable degree in increasing industry's knowledge of this all-important phase of processing. For security reasons the practical applications of the new types of pumps developed can not yet be revealed publicly. However, the engineers who participated in this phase of the project have brought to their parent companies a vastly increased lore of new techniques.

Perhaps the most significant advance in pump design which has been most successfully accomplished is the utilization of supersonic velocities of a very high order.

Instrumentation

If pumping is the heart of processing, then instrumentation is the brain. No continuous process could function efficiently without adequate automatic control. In the gaseous diffusion plant the problems of instrumentation were far greater than in any other industry because the theory involved the assumption that diffusion took place through an infinite number of stages, whereas practicability dictated that such stages be limited in number.

Even so, several thousand stages were required, necessitating the most precise, continuous, automatic, analytical control instruments ever produced by man. This refinement is one of the outstanding features of the gas diffusion plant and constitutes one of its most important applications to industry today. Instruments which before had existed only in research laboratories were improved upon and adapted to commercial use. Completely new prototypes were put into mass production.

Leak Detector

A second development, aptly and simply called "the leak detector", is more sensitive than any other existing device previously utilized for the same purpose. It played an important part in ensuring that all parts of the gaseous diffusion plant were vacuum tight. Any leaks out of or into the system would be damaging both from the standpoint of loss and contamination of an exceedingly valuable material. The leak detector is well adapted for locating annoying leaks in industrial high vacuum processing industries such as vitamin manufacture where even microscopic leaks undetectable by the familiar ammonia-hydrogen chloride method or Tesla coil method are still potent enough to prevent drawing the necessary high vacuum on the equipment. Other potential uses include the pre-testing of pressure and vacuum apparatus before putting it in service, checking equipment in operation to insure no wasteful loss or contamination, the testing of welds for minute pores which would otherwise escape detection, and insuring the physiological safety of refrigeration equipment employing toxic coolants.

Heat Exchangers

Of great interest is the development of a new type heat exchanger. Since an unavoidable concomitant to pumping gas is heating it and since enormous volumes of gas were processed, individual cooling units for each stage had to be developed. A brand new type of heat exchanger was conceived for this purpose and developed up to the production stage. A manufacturer was then selected and shown how to make it even to the extent of redesigning his equipment so that thousands of units could be turned out quickly.

It should be borne in mind that the benefits mentioned above accruing to American industries as a result of knowledge gained in the development of the gas diffusion plant represent only a small part of what is permitted to be revealed at this time.

Air Conditioning "Map" Is Provided by Psych Chart

Air Conditioning Engineers Can Use Psychrometric Chart Not Only for Calculations But to Explain Desired Results, Methods of Getting Them

AIR CONDITIONING engineers utilize as a matter of routine the psychrometric chart and psychrometric methods in making their calculations. A further use of the psych chart — in any one of its many available forms—is as an air conditioning "road map," to illustrate the desired objectives of an air conditioning system and the available methods of reaching these objectives.

Usually, there is more than one way of providing the required air conditions in any particular case, and the choice of the best method involves consideration of a variety of factors. This is the job of the trained air conditioning engineer. But during the process of choosing the desired method, a number of more or less technical points must be explained to others who are not to be expected to know the psychrometric details. The psych chart, with various zones plotted on it, is a useful tool in this connection—in addition to being an aid to the air conditioning engineer himself in making the necessary calculations.

Temperature and Humidity Are Basic

The psychrometric chart deals with the two truly basic factors which are essential to proper air conditioning—the temperature and humidity of the atmosphere before and after treatment. It is the combination of these two factors that gives us all atmospheric conditions. Therefore, they must be considered most important when correcting an undesirable atmosphere to obtain either personal comfort or to produce a suitable condition for industrial purposes. In general, only after these two factors have been properly considered do such matters as filtering, air movement, air distribution, etc., become important.

Temperature and humidity do not have characteristics basically common to one another, temperature dealing with heating or cooling and humidity concerning the amount of moisture in the atmosphere. Although closely interrelated, the two should not necessarily be considered inherently bound to one another, but rather as individual factors involved in obtaining a desired condition.

The primary steps in designing an air conditioning installation include determination of the air conditioning load (quantity of heat to be removed, heat losses, moisture content, etc., volume of air involved in which the temperature and humidity are to be changed as desired), selection of equipment to satisfy the load (capacity of units adding or removing heat and altering the moisture content of the air), and distributing the load (air movement, filtering or purifying the air, etc.).

Upon the premise that the initial and final temperatures and humidities are the two most important factors, the calculation of the load not only embraces the use of the psychrometric chart, but also requires experience and judgment in the selection of all factors involved. In many instances the load may be considered as a straight cooling load, and correct Btu-volume relationships set up accordingly. However, it is often possible that the humidity load is equally or more important than the heat load. The psychrometric chart offers the means of accurately determining this load and of indicating what steps must be taken to cope with it.

Accurate determination of the load obviously is to be followed by the selection of proper equipment to handle it, again bearing in mind that the humidity load as well as that of temperature (sensible heat) must be adequately handled. The equipment selected may also take into consideration any future expansion of the conditioning system. Hence, unless the basic load and the factors which make it up are accurately determined, any available factor of safety for such a contingency cannot be provided.

THE RIGHT air conditioning design is usually a matter of one of several possible engineering choices, and there are a number of factors that determine the proper answer. The psychrometric chart is not only useful to air conditioning engineers in making calculations, but is also of value as a "road map" in visualizing and explaining different processes of arriving at desired atmospheric conditions. To facilitate this use of the psych chart, different zones have been superimposed on the chart reproduced here, and the text discusses a number of the ways such a chart can be employed.

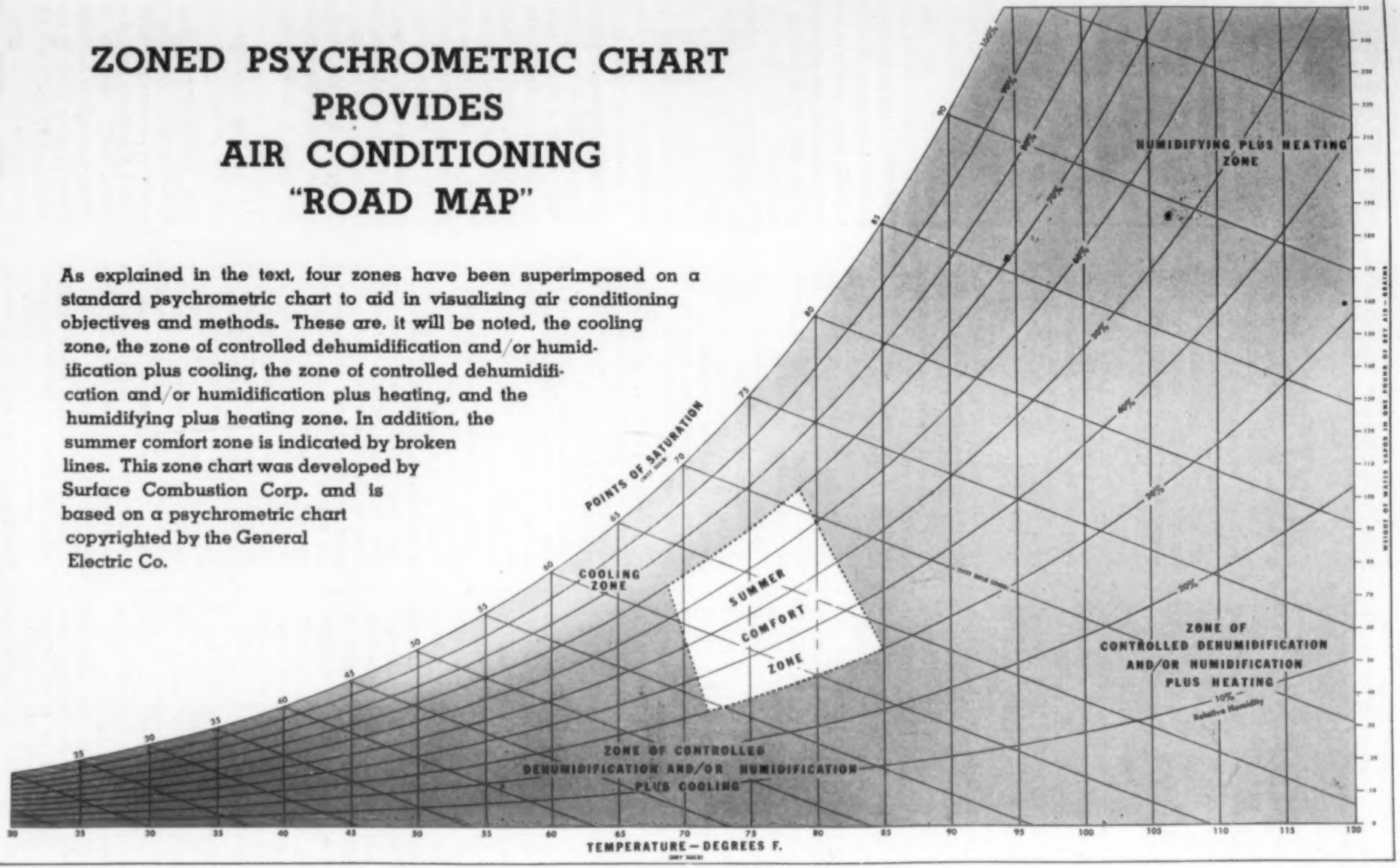
Visualizing Psychrometric Methods

To the layman the ordinary psychrometric chart appears as a maze of curved and straight lines, largely meaningless. To the air conditioning engineer it serves as a "road map" on which to chart a course from a natural or initial (design) atmospheric condition to a desired condition. In a literal sense it serves as a visualizer, indicating the change in relative humidity which occurs with a given temperature change, and from which the importance of the humidity relationship may become evident.

A zoned psychrometric chart, such as the one reproduced on the next page, visualizes the atmos-

ZONED PSYCHROMETRIC CHART PROVIDES AIR CONDITIONING "ROAD MAP"

As explained in the text, four zones have been superimposed on a standard psychrometric chart to aid in visualizing air conditioning objectives and methods. These are, it will be noted, the cooling zone, the zone of controlled dehumidification and/or humidification plus cooling, the zone of controlled dehumidification and/or humidification plus heating, and the humidifying plus heating zone. In addition, the summer comfort zone is indicated by broken lines. This zone chart was developed by Surface Combustion Corp. and is based on a psychrometric chart copyrighted by the General Electric Co.


HUMIDIFYING PLUS HEATING ZONE
POINTS OF SATURATION
COOLING ZONE
SUMMER COMFORT ZONE
ZONE OF CONTROLLED DEHUMIDIFICATION AND/OR HUMIDIFICATION PLUS HEATING
10% Relative Humidity
ZONE OF CONTROLLED DEHUMIDIFICATION AND/OR HUMIDIFICATION PLUS COOLING
TEMPERATURE — DEGREES F.

pheric conditions and changes therein which may be desired in providing the proper conditions for an air conditioning installation. The chart lends itself to the zoning of the functions of temperature and humidity, and when these zones have been separated, the conditions and requirements involved become more easily apparent.

The psychrometric chart reproduced here has been divided into four zones, as follows: cooling zone, zone of controlled dehumidification and/or humidification plus cooling, zone of controlled dehumidification and/or humidification plus heating, and the humidifying plus heating zone. In addition, the summer comfort zone is indicated by broken lines. No absolute boundaries can be drawn to separate these zones from any of the others, but the areas on the chart are believed to be fairly accurate, and the blending of the various zones at the boundaries indicates that there is overlapping. Note that the humidity factor is a definite element in all of the zones except the cooling. This is evidence of its importance in air conditioning practice where chill, shock, and clamminess are hazards to comfort, and where excessive humidity is detrimental to product quality or is a handicap to production.

Using the Zones

To explain how the zones on the psychrometric chart can indicate air conditioning problems and aid in visualizing their solution, let us consider four sets of conditions. The four conditions are representative of as many commercial requirements, rather than those for personal comfort, although the latter may be handled in a similar manner. In all four cases, the initial or natural condition of the atmosphere is assumed as 95 F dry bulb and 79 F wet bulb.

1) Desired condition of 50 F and 85 per cent relative humidity; a condition such as this may be used in food storage (processing) where a cool, damp atmosphere tends to prevent dehydration, yet the product must be kept above the freezing point.

It will be noted that the latter falls definitely within the cooling zone. Hence, the application of one of several cooling methods only is required. Note, however, that the desired condition is close to 100 per cent relative humidity so that if either the initial humidity is higher, or the temperature slightly lower, precipitation of moisture may occur.

2) Desired condition of 75 F and 30 per cent relative humidity. This may be desirable in several processing operations where a low humidity and a "medium" temperature are required.

This condition falls within the zone of controlled dehumidification and/or humidification plus cooling and both temperature and humidity must be considered. While lowering the temperature may be sufficient if a higher humidity than given above is acceptable, it is highly probable that both must be handled by the installation.

In mapping the approach to the desired condition, three methods are in common use:

Method "A" consists of cooling the air to its dew point to precipitate the excess moisture, then reheating to the desired temperature. The air is cooled by city or well water or refrigeration depending upon the prevailing temperature of the water supply.

Method "B" involves the use of liquid chemical dehumidification to provide the decrease in humidity, while supplemented by one of the above methods of cooling to reduce the temperature somewhat.

Method "C" is the utilization of the "dry" chemical moisture adsorbing agents. As the process of adsorption goes on, heat is liberated so that aftercooling is required down to the desired temperature condition.

3) Desired condition of 100 F and 10 per cent relative humidity. Many industrial drying applications involve conditions such as this.

This condition falls well within the zone of controlled dehumidification and/or humidification plus heating, where there is a very real need for humidity control.

Three approaches are applicable in obtaining the desired condition:

Method "A" is to cool to the point of saturation, precipitate the moisture, then reheat to the desired condition. Due to the low desired humidity, however, the intermediate cooling temperature must be low. Hence, there is the possibility that the cooling coils may have to be held close to or below the freezing point. If freezing can occur, obviously any control of humidity is lost until the temperature of the coils is raised. Accurate control of the cooling coil temperature is, therefore, essential and any change in air flow or other operating condition may cause trouble with the installation. The cost of reheating from the low temperature of saturation to the maintained condition must be given consideration.

Method "B" utilizes liquid chemical dehumidification to reduce the moisture content to 10 per cent relative humidity, then the addition of heat to raise the temperature.

Method "C" is the utilization of the "dry" chemical moisture adsorbing agents, with aftercooling down to the desired condition.

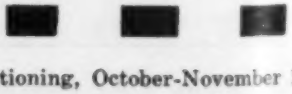
4) Desired condition of 100 F and humidity above 50 per cent.

In this zone (humidifying plus heating) the increased capacity of the air to retain moisture usually indicates that moisture must be added to the air if high humidity is desired. Applications in this zone are relatively fewer than in the others, but include a number of industrial processes.

The foregoing examples—while only four of many possible ones—will show why the psychrometric approach is sound and most likely to bring out the requirements to be met. In the areas on the chart where one zone blends into another it is often difficult to be sure that both the equipment and the controls provided for it are able to cope with the load to be handled. Here, experience and a knowledge of all possible variations from the initial and the final condition are helpful. Local weather and other conditions, initial and maintenance costs of equipment, reliability of control, and frequency of available service are all factors in addition to the basic air conditioning principles which must be met to provide an installation which will satisfy all concerned.

It is possible that straight cooling methods can satisfactorily handle a particular application. Likewise, it is just as possible that controlled dehumidification-humidification or various other drying methods for handling the humidity factor will give the desired result, independent of temperature. In any event, the psychrometric approach is basic, and with the visualized chart it is possible to explain the approach to the layman, so that he can appreciate the thorough manner in which his problem of air correction is being treated.

YOU ARE INVITED to throw bricks or bouquets at the editor. Your comments on articles published in HPAC —or subjects you believe we are neglecting—will certainly be appreciated, and will be helpful in planning future issues. What do you like this month? What don't you like?



NDHA Reports Review the Year's Developments in District Heating

BECAUSE OF wartime restrictions, this year's annual meeting of the National District Heating Association was confined in attendance to the officers, executive committee members, and technical committee chairmen. However, the committees had been at work as usual during the year, and many worthwhile technical reports and papers were given; the association is sending its membership these reports in pamphlet form to secure written discussion. . . . We review here the highlights of the reports; much of the material is pertinent to heating and piping in general, as well as to district heating in particular.

DUE TO WARTIME conditions, the annual meeting of the National District Heating Association, held this year in Cleveland, was attended only by officers, members of the executive committee, and chairmen of the technical committees. However, as the committees had functioned during the year, those present heard not only the reports of the officers, but many worthwhile technical papers.

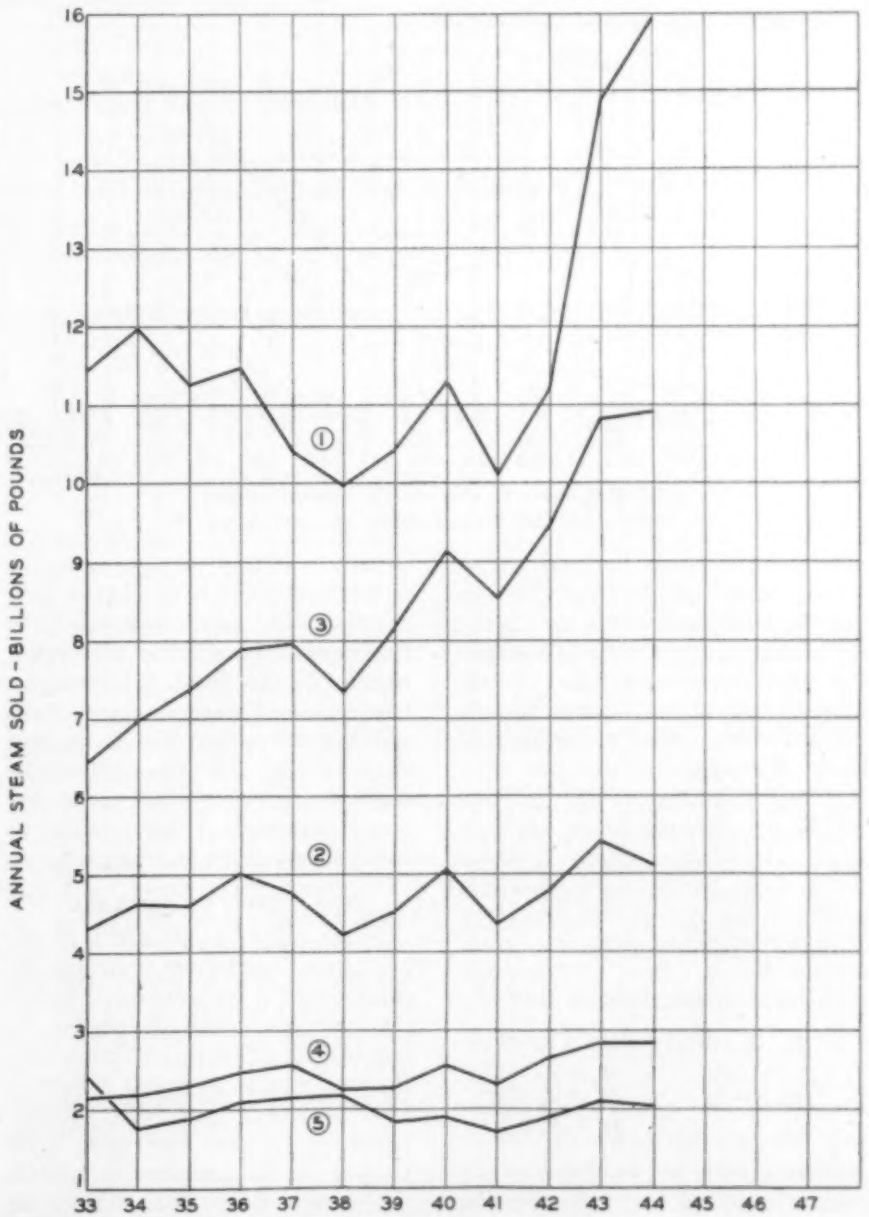
Several of the reports pertaining to district heating developments, general heating problems, and underground steam piping were highlighted in the September HPAC. The following paragraphs, covering the other reports, complete our summary of the NDHA's 36th annual meeting:

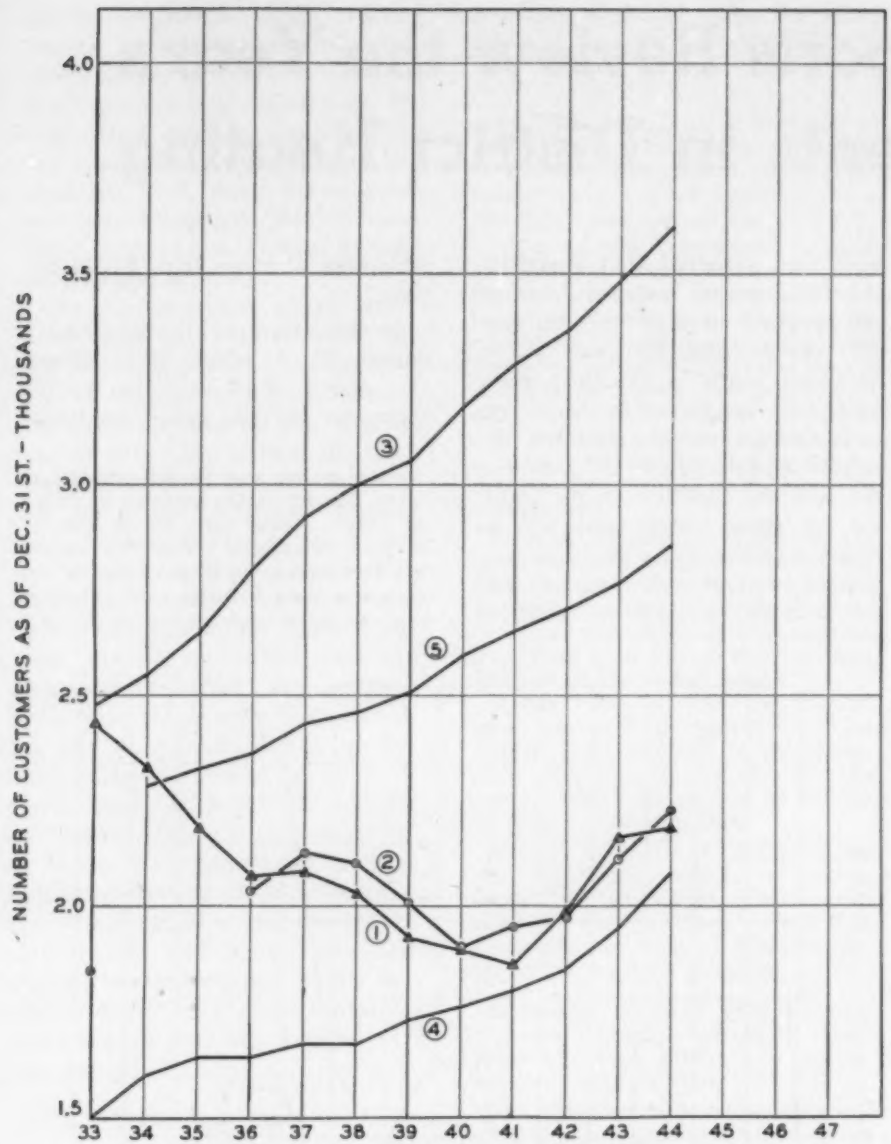
Testing Condensate Meters

Three studies were completed during the year by the association's meters and accessories committee. Henry L. Warhanek, Wisconsin Electric Power, committee chairman, reported that lengthening the interval between tests of the accuracy of size "A" condensate meters from one year to two or three years is practical when conditions conducive to proper results are maintained and that the results obtained with "B" meters so far indicate that the longer interval for these meters also will be found satisfactory. For a company with a total of approximately 660 "A" and "B" meters, the saving is estimated at more than $1600 per year.

In the second of the committee's papers, P. A. Hyde, Ohio Edison Co., Akron, drew attention to the increased safety, better employee

Annual steam sold by five groups of large district steam utilities. Included in these groups are 20 of the 27 largest companies. The five curves are for companies in the order of decreasing annual steam sales; that is, the smaller companies are in Curve 5





Similar curve to the one for annual steam sales, but showing number of customers

feeling, and customer satisfaction that had resulted from the practice of bringing in for testing only the drums and bearings of the larger sizes of condensate meters instead of the whole meter as formerly was done.

In the final paper, Roy M. McQuitty, Union Electric Co. of Missouri, St. Louis, showed that an orifice constant can be determined quite accurately by the use of water in place of steam.

Standardizing Degree Days

NDHA Secretary John F. Collins, Jr., chairman of the national joint committee on weather statistics, said that representatives of various heating groups had agreed on many points in regard to standardization of the computation of degree days and that now these proposals were ready for ratification by the organizations represented. Computing new standard normal degree days for the 200 order No. 1 weather stations with paid personnel can be begun soon. For the large group of lesser stations, a way must be found to make the computations.

New Forms of Insurance

In his report as chairman of the insurance committee, James E. Harris, of the Philadelphia Electric Co., gave the latest information in regard to many forms of insurance. He said a new technical definition for "accident" had been promulgated in boiler insurance. He pointed to an increase in annual fire losses from $315,000,000 in 1942 to $424,000,000 in 1944 and said inevitably a rise in fire insurance rates would result; he recommended protection programs and good housekeeping. He said that single comprehensive liability policies are now being written so that insurance buyers can now feel assured that all their legal liability is covered. Similarly comprehensive policies are being written to cover all forms of dishonesty, disappearance, and destruction, including loss of money and securities by fire. Regarding war damage insurance, he informed the meeting that one proposal was to use the premium funds to pay Philippine property damage losses. He warned that rising costs make it necessary to maintain adequate coverage for losses by fire.

The report of the sales development committee was made by its chairman, D. W. Loucks, of the Allegheny County Steam Heating Co. He said that from replies received to a questionnaire sent out to member steam utilities, it appeared that only 75 per cent of them are interested in promoting new business. Two-thirds of the business adjacent to the company distribution systems has been sold to one-half of the total potential customers. To sell those remaining will be more difficult, since the future sales average will drop from 2100 M lb to 825 M lb. He said the answers to the questionnaire indicate that the best sources of steam business are (1) existing and (2) prospective buildings along existing steam lines and the greatest obstacles to expansion are (1) the cost of steam and (2) the reluctance of prospects to evaluate intangible advantages.

Reemploying Veterans

The war service committee chairman, Leonard S. Phillips, New York Steam, read a paper on Considerations with Respect to Reemployment of War Veterans, which included "the five conditions under which a veteran can claim his old job": (1) If his job was not temporary; (2) if he can certify satisfactory completion of his military service; (3) if he still is qualified to hold the position; (4) if he applies within 90 days; and (5) if his employer's circumstances have not so changed as to make it impossible or unreasonable. He said

that it is estimated that only 40 per cent will want their old jobs back and "they must accept them under any new circumstances that may have arisen in the interval." In closing he advised employers who are in various states of preparedness to keep posted, to consider what has happened both to the veteran and to the organization, and to have the most suitable person give each returning veteran an honest welcome.

Mr. Warhanek commented that some soldiers in service resented receiving questionnaires about their taking the old job back and that their answers to such inquiries were not accurate for anyone in doubt would say he was coming back to the job.

G. W. Ousler, of Pittsburgh, suggested in a written discussion, that if a suitable former employee who had been an army officer returned, his experiences would make him most satisfactory for employment as an interviewer of returning veterans.

As chairman of the educational committee, J. Earl Seiter of the Consolidated Gas Electric Light and Power Co. of Baltimore, said that the job assigned to his committee of writing an up-to-date constitution and bylaws for the NDHA was almost complete and that it would be ready for adoption at the 1946 annual meeting. He said plans for a new third edition of the NDHA's handbook are in a very preliminary stage, but with the second edition now almost completely sold they will be pushed in the next year. He commented on the articles of a popular nature that have come off the press in the past year on district heating and said preparation of an illustrated lecture on district heating is being considered. He recommended that arrangements be made for more traveling by the association secretary and that more geographic sections be formed.

McQuitty Is President

In the closing session, the retiring president, S. S. Sanford, announced that Roy M. McQuitty of the Union Electric Co., St. Louis, had been elected president of the NDHA for the coming year; John F. Malone of the Consolidated Gas Electric Light and Power Co., Baltimore, first vice-president; Robert D. Martin, New York Steam Corp., second vice-president; Henry L. Martin, Boston Edison Co., third vice-president; and that D. W. Loucks, Allegheny County Steam Heating Co., Pittsburgh, and George H. Tuttle and himself, both of The Detroit Edison Co., had been elected to the executive committee.

During this same session, Hal C. Kimbrough, Chicago, consultant in district heating, a pioneer in the field, and for many years an active member of the NDHA, and Arthur D. Leach, a retired steam official of the Northwestern Electric Co., Portland, Ore., very active in the industry in the Pacific Northwest and an indefatigable worker for the NDHA, were elected honorary members of the association by unanimous ballot.

At the annual dinner Mr. Sanford was given his past president's badge by Toastmaster Leonard S. Phillips, and Cyril Tasker, director of research of the American Society of Heating and Ventilating Engineers, spoke on raising money for research work.

You'll Still Have to Work in the Atomic Age

[from the Industrial Bulletin of Arthur D. Little, Inc.]

With the cyclotron and other methods it is now possible to cause the disintegration of minute proportions of more common elements. In effect it is possible to strike sparks from these materials but not to start a fire, a self-supporting disintegration releasing energy at a useful rate. When it does become possible to start and control such a fire, the age of atomic power will have dawned.

When that day comes the world will not become a workless utopia. Atomic fission may in fact some day supply unlimited amounts of virtually free energy, but energy in the form of fuel is now neither scarce nor expensive. The fuel cost of a kilowatthour of electricity is only a minor part of the total cost, and the share contributed by electricity to the final cost of most consumer goods is minute. In 1940, of a total United States labor force of 50,000,000, only 700,000 were engaged in producing fuels. Far more workers were making energy-conversion devices such as stoves, electrical equipment, and automobiles; and some 18,000,000 were engaged in distribution and service trades which could hardly be greatly affected by a new power source. The availability of atomic power, however, by ending dependence on coal and petroleum as fuels, could cancel the economic advantages of areas now possessing these fuels and might eventually make the whole world equally desirable from an economic viewpoint.

The availability of a practically weightless fuel could well have revolutionary effects in special fields, particularly transportation, where speed and range of aircraft (or space craft) would become unlimited by problems of power supply. If really cheap and unlimited energy should become available, it would permit consideration of projects which are now out of the question, such as remaking large areas of the earth's surface. Even with such an energy source, however, it would still be necessary to develop and make energy-conversion devices appropriate to particular applications, just as it was necessary to develop the steam engine before the energy of coal could be used mechanically.

During the week before D-Day, communications requirements reached peaks at least 50 per cent over the previous estimates

Air Conditioning an Essential for Underground Invasion Headquarters

ONE OF THE most secret areas of the war, unknown even to the residents of the city above it, was the combined headquarters which was the command and focal point of the operations preceding, during, and immediately following the invasion of Europe. Being far underground, it was essential that complete air conditioning and heating facilities, and provisions for careful control, be included. . . . This description of a most unusual installation, by Mr. Hutchinson, of the Minneapolis-Honeywell Regulator Co., is based on information, photos, and diagrams supplied by the London representative of that company.

By William B. Hutchinson

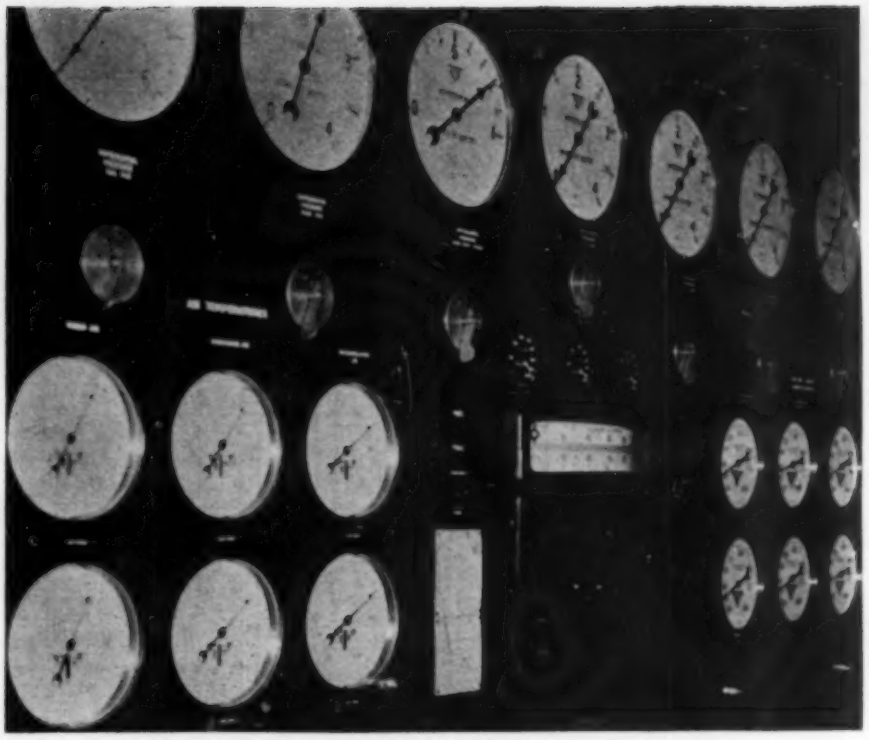
FAR BELOW THE earth's surface, tunneled out of rock and clay, was one of the most secret areas of the war. It was unknown even to the residents of the city above it. Called Combined Headquarters, these caves actually were the command and focal point of all operations preceding, during, and immediately following the invasion of Europe.

Today it can be revealed that underneath Plymouth, Devon, England, His Majesty's Royal Engineers built for the United States Army and Navy a complete and unique headquarters. From this one spot in England every ship in the invasion fleet, every landing barge, every plane, and every company of troops was directed—and through the headquarters all communication for the greatest invasion in history was handled.

At the outset, the entire conception of the project was British, and in January 1943 dynamiting for the tunnels was started. Not long after, however, it was found that a large clay formation affected the solidity of the entire structure above and for a period it looked as if the whole project could not be completed in the prescribed time for D-Day. But in April 1943 the job was resumed. At a meeting which took place at that time, it was stated that the purpose of the unusual construction task was "to provide the United States forces with headquarters capable of launching the amphibious attack and controlling such forces in France as the U. S. forces may desire." President Roosevelt alluded to the headquarters in a speech and said the project was a typical example of reverse lend-lease. All of the equipment but the air conditioning controls was supplied by the British.

Because the headquarters was to operate far underground, it was essential that complete heating and air conditioning facilities be included in the plans. Practically all of this technical engineering and equipment was supplied by G. N. Haden and Sons, heating and air conditioning contractors of London. The general layout of the combined headquarters comprised large rooms for operational divisions of the Navy, Army, and Army Air Forces, provided offices for flag and general officers and members of their staffs, radio facilities for 40 transmitting and receiving stations (20 each for the Army and Navy), teletypewriters capable of handling 50 circuits (18 Navy and 32 Army), complete telephone switchboard facilities consisting of a 16 position administrative and four position operational board, separate Army and Navy ciphering rooms, and separate message centers and communications rooms for the Army and Navy respectively.

In addition to these functional areas, extensive mechanical equipment was included in another section of CHQ, comprising standby diesel driven electrical generators for emergency power supply, a complete blower, filter and ventilation system, transformers, switchboards, gas and smoke filters, and water and drainage systems.

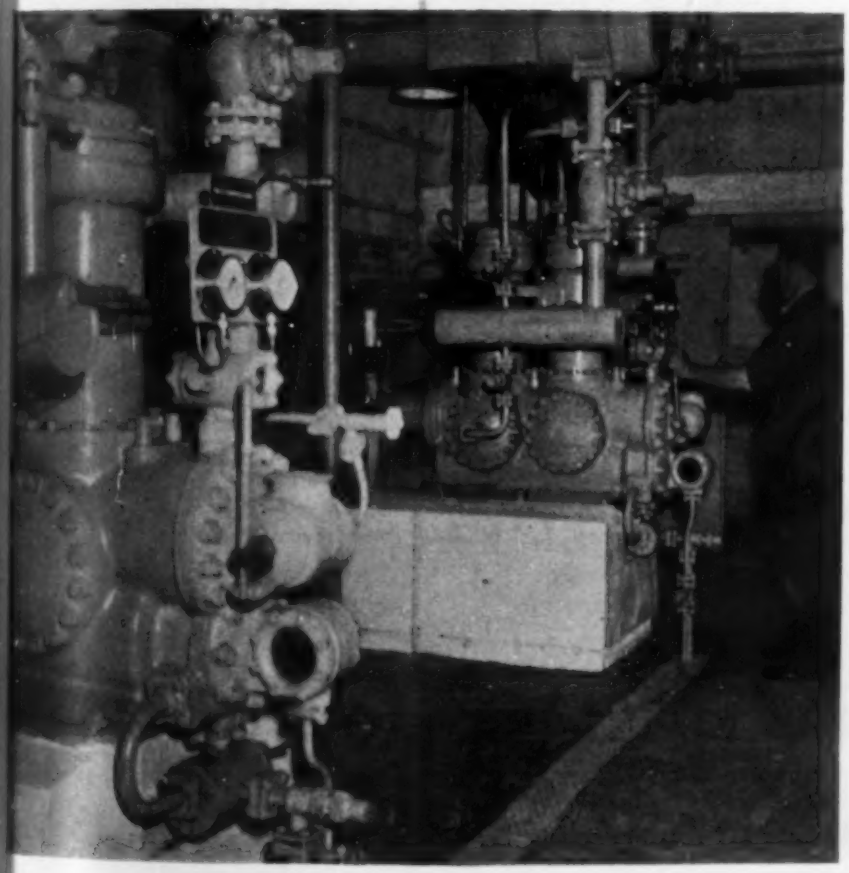


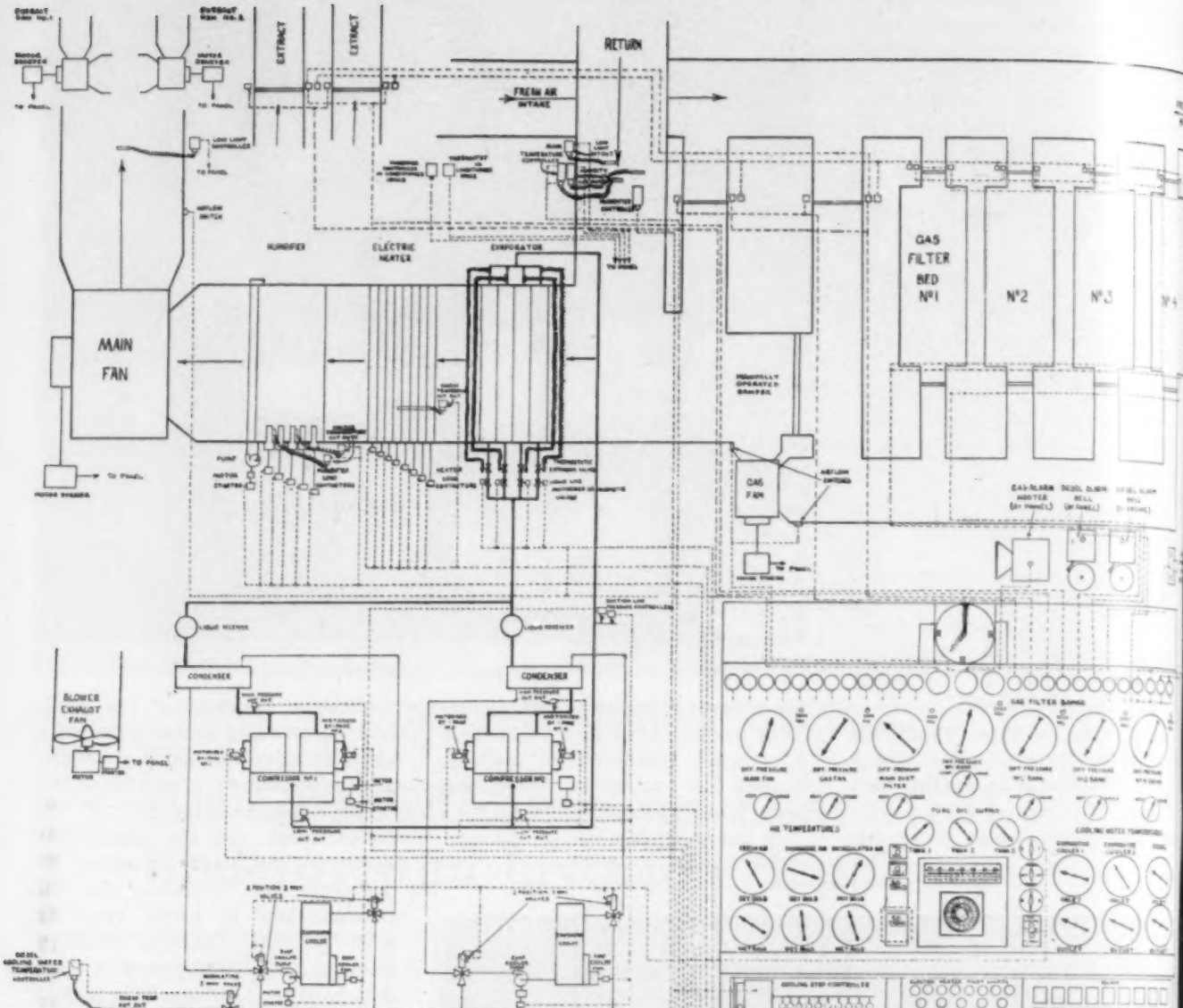
The air conditioning control panel

In the pre-D-Day period, the communication function of the headquarters was largely concerned with administrative traffic, i.e., traffic concerning logistics, personnel and maintenance requirements of the forces afloat and the amphibious bases in the United Kingdom. At the same time, however, the tremendous load of traffic resulting from the many training exercises prior to the actual invasion were also handled. During this period, dispatch traffic increased nearly tenfold over what previously had been determined as "normal."

From D-Day minus seven until D-Day itself, communications requirements reached peaks at least 50 per cent over previous estimates. Radio circuits were increased until the U. S. Navy had in operation 22 individual circuits, of which 12 were two-way, sending and receiving. In a like manner teleprinter circuits were increased as all existing circuits maintained a full load of traffic. On D-Day minus two, the only solution to the problem of handling this vast volume of messages was to place all personnel on a watch-in-two basis since it was impossible to obtain additional trained personnel. All watches remained on the "watch-and-watch" schedule until D-plus twelve, when traffic from the beachheads began to taper off.

The compressors





Schematic layout of the air conditioning system

This one headquarters was designed to handle the entire communications by cable and radio between the United States Navy communications ship in the Channel and everything coming from the Normandy coast. If necessary, the general on the coast could automatically get in touch with London or Washington through the CHQ immediately. It remained in operation as a communications center until D-plus 120, but by that time, with American troops far inland and the transfer of much operational control of U. S. ships in the assault area to the far shore, there resulted a gradual reduction of operational dispatch traffic. At that time, the services were successful in installing a teleprinter cable circuit to Cherbourg using high-speed American teleprinter equipment which eliminated the "bottleneck" of traffic to the far shore and CHQ's important task was fulfilled.

AIR CONDITIONING IN INDUSTRY HELPS TO WIN THE BATTLE OF PRODUCTION

Fundamental Investigation of GRAPHITIZATION OF PIPING

THREE previous progress reports on the fundamental investigation of graphitization have been distributed in mimeograph form to those interested and published in the October 1943, April 1944, and October 1944 issues of the Edison Electric Institute Bulletin. The first report covered the preliminary field survey and outlined the program to be carried out at Battelle Memorial Institute. The second report listed the 10 questions which formed the basis of that program, described the work in progress at Battelle, classified the degree of graphitization reported for some 38 different piping systems, and called attention to the desirability of limiting the extent and duration of temperature swings above design temperatures. The third report presented a digest of statements on independent laboratory investigations, described the Battelle findings up to that time, and attempted to relate both to the original 10 questions. Suggestions and tentative recommendations were made regarding: (1) stress-relieving temperature; (2) restoration of partially graphitized joints; (3) pipe material for 850 F to 950 F service; (4) casting material for 850 F to 950 F service; and (5) heat treatment of pipe and pipe bends prior to installation.

In this, the fourth report, the work done at Battelle since issuance of the third report is described, the findings are summarized, and recommendations previously given are discussed in the light of subsequent developments.

Work at Battelle Memorial Institute

Some 123 of a total of 213 samples of welded and unwelded carbon-molybdenum and carbon steel piping materials remain on test. Samples in general are bars ½ to 1 in. thick, 1 in. wide, and 6 to 8 in. long. A ⅜ in. micro-specimen has been cut from each bar at approximately 500, 1500, 3000, and 5000 hr intervals of heating at 925 F and 1025 F, and at 1125 F followed by cyclic heating at temperatures of 950 F, 1050 F, 1150 F, 1050 F, etc., with weekly changes of temperature for the last 1150 hr of the 5000 hr period.

Unwelded Samples of Carbon-Moly Pipe

Microscopic examination of unwelded samples at the end of 3000 hr heating at 925 F, 1025 F, and 1125 F revealed a trace of graphite in both the high- and low-aluminum varieties of carbon-moly pipe. The high-aluminum pipe was used pipe from the Springdale plant which was reported to have been deoxidized with 1½ to 2 lb of aluminum per ton. The low-aluminum pipe was new pipe deoxidized with ½ lb of aluminum per ton. At the end of 5000 hr at 925 F, the graphite was classed as of the random type, little in amount, and fine in size for both varieties of pipe. Only a little more graphite was produced by heating for 5000 hr at 1025 F than at 925 F, or by heating for 3850 hr at 1125 F followed by 1150 hr at temperatures varying from 950 to 1150 F. The finding of graphite after 3000 hr in samples heated at 925 F, particularly in the cast of low-aluminum pipe, is significant. No graphite had been found in the same specimens at the end of the 1500 hr heating period, as was reported in progress report No. 3. Apparently the incubation period for the low-aluminum carbon-moly pipe is longer than for the high-aluminum type, but at the 5000 hr point about the same amount of random graphite had formed. No marked differences in amount of graphite were found for specimens given different heat treatments prior to testing. This finding enabled tests on 70 per cent of these specimens to be discontinued at the end of 5000 hr.

Bead-Welded Carbon-Moly Specimens

Examination of bead-welded high- and low-aluminum carbon-moly specimens after testing periods of 3000 hr and 5000 hr at 925 and 1025 F, and after 3850 hr at 1125 F followed by 1150 hr at 950 to 1150 F showed no evidence of segregated graphite at the edge

SINCE THE failure in 1943 of a large carbon-molybdenum pipe carrying high pressure, high temperature steam at a central station power plant, there have been and are being carried on a number of investigations on graphitization of piping, to which the failure was attributed. One such study was described in a paper by H. N. Boetcher presented at an informal session held during the 1944 annual meeting of the American Society for Testing Materials and published in the October 1944 ASTM Bulletin; excerpts from this paper were given in the December 1944 HPAC. . . . A brief summary of other information on graphitization, and suggested maximum operating temperatures for various pipe materials, appeared on pages 591 and 592 of the October 1944 issue of HPAC. . . . The progress report given here discusses an investigation conducted by the joint EEI-AEIC subcommittee on graphitization of piping (L. E. Hankison, T. E. Purcell, Alex D. Bailey, chairman, Sabin Crocker, secretary). It is reprinted by permission from the July '45 EdisonElectricInstituteBulletin

of the weld heat-affected zone. However, appreciably larger nodules of random graphite were found in the bead-welded high-aluminum specimens than in the unwelded specimens of the same material. Appreciable increases in amount of graphite were noted between the 3000 and 5000 hr tests of the high-aluminum pipe. Both samples were from used Springdale pipe. Practically no difference was found between the welded and unwelded samples of new low-aluminum pipe. Only a slight increase in amount of graphite was found between the 3000 and 5000 hr tests of the low-aluminum pipe.

A second series of bead-welded specimens representing high-aluminum and low-aluminum carbon-moly pipe and a carbon-moly header rated as "normal" in the McQuaid-Ehn test has been examined after 2000 hr at temperatures of 925, 1025, and 1125 F. Small amounts of fine random graphite were reported for the high-aluminum sample, traces in the low-aluminum pipe, and none in the "normal" header material.

Bead-Welded Carbon-Steel Specimens

Bead-welded specimens of high-aluminum (1.3 lb Al per ton) and low-aluminum (0.4 lb Al per ton) plain carbon steels have been examined after 500, 1500, and 3000 hr testing periods. Testing temperatures were the same as for the carbon-moly steels; i.e., 925 F, 1025 F, and 1125 F. Graphitization of carbon steels at 925 F was found to be considerably more rapid than graphitization of carbon-moly steels at 1025 F. Even 500 hr was sufficient to develop graphite in all the high-aluminum samples and in some of the low-aluminum samples as well. Little difference was noted between the three testing temperatures. At the end of 1500 hr, appreciable amounts of graphite were present in all specimens. However, larger particles and greater numbers were observed in the high-aluminum steels.

The most important feature observed in the bead-welded carbon-steel specimens was the tendency of the graphite to segregate at the low temperature edge of the weld heat-affected zone in all except those specimens that had been stress relieved at 1370 F. This temperature is about 55 F above the lower critical point of the material tested. This is the first evidence of preferential graphitization being produced by the bead welds. This segregation was more fully developed by the 3000 hr heating period at 925 F and at 1025 F, and by 1850 hr at 1125 F followed by 1150 hr at 950 to 1150 F. The base material in all the samples appeared to be nearly devoid of carbide containing areas, i.e., it was decarburized as the result of graphite formation. One-third of the specimens have been removed from test, but the 48 specimens remaining should demonstrate whether further migration of graphite to the heat-affected zone will occur, and whether the Springdale type of segregated graphite will result in these carbon steels.

Butt-Welded Carbon-Moly and Chrome-Moly Specimens

Butt-welded joints between plates of straight silicon-killed carbon-moly and between plates from experimental heats* of high aluminum (2.5 lb Al per ton) and straight silicon-killed carbon-moly with varying additions of chromium have been examined after 1000 hr at 1025 F. Specimens as-welded, stress relieved at 1200 F and 1300 F, and normalized at 1650 F were tested. No positively identifiable graphite was found in any of these specimens, although a trace of graphite was reported for a straight silicon-killed carbon-moly as-welded specimen with 0.50 per cent chromium addition after 1000 hr at the cycling temperature of 950 to 1150 F. These findings will be checked after 1500 hr further heating.

A butt-welded joint between unused short lengths of high-aluminum and low-aluminum carbon-moly pipe made by the Detroit Edison Co. was sectioned and across-the-weld samples were heat treated at 1200 F, 1300 F, and 1650 F. Examination at the end of 1000 hr at 1025 F showed traces of graphite in the high-aluminum pipe in the as-welded and 1200 F and 1300 F stress-relieved conditions. None was found in the specimen normalized at 1650 F. No graphite was produced in the low-aluminum pipe by 1000 hr at 1025 F in the as-welded or in any of the heat-treated conditions. As-welded samples also were heated at 925 F and at the cycling temperatures of 950 to 1150 F. Traces of graphite were reported for the high-aluminum pipe, but none for the low-aluminum pipe. The identification of graphite in the high-aluminum sample at 925 F was somewhat indeterminate. A further heating period of 1500 hr should give more positive results.

A butt-welded joint between high-aluminum and straight silicon-killed chrome-moly pipe has been made up by the Consolidated Gas Electric Light and Power Co. of Baltimore for use in the Battelle investigation. These materials are of especial interest since they contain about ½ per cent chromium as a preventive of graphitization. Tests should demonstrate the effectiveness of this amount of chromium and whether there is a need for limiting the amount of aluminum used in deoxidation.

Reports from Operating Companies

Examination and periodic re-examination for graphite in welded joints of carbon-moly and carbon-steel piping is being conducted by many operating companies. In one case having 23,000 hr at an average temperature of 942 F, with occasional swings to 1000 F for short periods, no graphite was found. The pipe material was made to the coarse grain requirement of A206-39T, but was reported to have been deoxidized with 1 and 1.3 lb of aluminum per ton, respectively, in the different heats supplied. No graphite was found in another plant, having 23,000 hr at an average temperature of 907 F, with swings to 935 F. This pipe material was made to ASTM A206-38T which did not include grain size requirements. However, since it was deoxidized with only 0.4 lb of aluminum per ton, it conformed to the low-aluminum type of carbon-moly pipe.

A different graphitization phenomenon has recently been found

* McQuaid-Ehn tests showed the high-aluminum material to have an ASTM grain size of 7 to 8 and to be "abnormal," although the material having a chromium addition of 0.70 per cent was only slightly abnormal. The straight silicon killed materials had a grain size of 1 to 3 and were classed as "normal."

in the Springdale pipe about 2 ft from the original failure. Graphite appears to have precipitated out along slip planes in the old pipe for a distance of about 10 in. from the replacement weld. The orientation of the slip planes is such as could have been produced by a combination of hoop tension and axial compression or by torsion.

Reports on Other Research Investigations

Several formal reports and a number of verbal reports have been received on other graphitization investigation. The Philadelphia Electric Co., Consolidated Gas Electric Light and Power Co. of Baltimore, General Electric Co., National Tube Co., Public Service Electric and Gas Co. (New Jersey), Lunkenheimer Co., Babcock and Wilcox Co., and the Detroit Edison Co. are among those actively engaged in such research.

Some of these investigations are so comprehensive and the heating periods planned are so long that only preliminary results are available at this time. Knowledge of the lines of attack to be followed and the free interchange of information on these investigations, however, have been of inestimable value to the Battelle investigation. It is hoped that complete reports of the several investigations will be presented at the earliest opportunity.

Summary of Findings

The specific cause of graphitization has not yet been determined. It appears that several interrelated factors are involved, some of which are still unrecognized. No marked difference in the rates of graphitization has been found for specimens normalized at 1650 F after heating to 2200 F and those air cooled from that temperature. Thus the fact that pipe ends at Springdale were upset without subsequent heat treatment is not considered a basic factor, although it may have affected the type of graphite formed.

Deoxidization practice appears to have a definite effect upon the time required to initiate graphite and the rate of its increase. Steels with high-aluminum additions (1½ to 2 lb per ton) generally are more susceptible to graphitization than are steels with low-aluminum additions (0.5 lb per ton). Straight silicon-killed steels are resistant to graphitization and in some cases appear to be immune. McQuaid-Ehn tests give useful indications regarding deoxidation practice. For a given deoxidation practice, molybdenum steels are more resistant than carbon steels. The addition of varying amounts of chromium to carbon-moly steels is under investigation and would seem to offer good promise.

Varying degrees of graphitization have been found in samples from steam lines and in the experimental specimens. Only the segregation of graphite at the low-temperature edge of the weld heat-affected zone and along strain lines as found at Springdale, and the heavily concentrated nodular type found in a few other locations, can be considered as serious enough to warrant replacement of welded joints or entire piping systems.

Discussion of Previous Recommendations

Recommendations and suggestions were given on five specific questions in progress report No. 3. On the basis of subsequent findings the following modifications seem desirable:

(a) Best Stress Relieving Temperature for Welds

Present indications are that heating both carbon steel and carbon-moly welded joints at a temperature around 1400 F is more effective than 1300 F in preventing graphite segregation adjacent to welds. It will not, of course, prevent random graphite formation in the body of the pipe if the material is susceptible to graphitization. Comprehensive tests to determine the best stress-relieving temperature and procedure are under way.

(b) Restoration of Partially Graphitized Joints

The restoration of partially graphitized joints by normalizing or by a somewhat lower temperature heating as a preventive of graphite segregation adjacent to welds seems to offer promise, but trials on actual pipe line welds have not been made. Where graphite of the chain or segregated type exists, restoration by heating has not proven successful in that the shock resistance is still impaired.

(c) Specification of Castings for 850 F to 950 F Service

As pointed out in progress report No. 3, the addition of an alloy to castings does not increase their cost proportionate to the increase in cost of pipe for an equivalent alloy addition. In order to retain the advantages of aluminum deoxidation, it seems desirable to specify chrome-moly or chrome-nickel-moly castings for temperatures of 850 F to 950 F. A low-aluminum carbon-moly casting material was suggested for 925 F service in report No. 3, but its actual development would not appear to be justifiable.

(d) Specifications of Pipe Material for 850 F to 950 F Service

A new specification has been developed under ASTM procedure for ½ per cent chromium—½ per cent molybdenum pipe that is expected to be highly resistant, or possibly immune, to any graphitizing tendency at temperatures up to 950 F. The deoxidation practice is governed by the requirement that the ingots and billets from which the pipe is made shall show a grain size of 1 to 5 on McQuaid-Ehn test. The allowable working stresses for this material are considered to be equivalent to those now given for carbon-moly pipe. One order for ½ per cent chrome -½ per cent moly pipe of this sort has been placed by Philadelphia Electric, while another order involving two heats, one made with 1¼ lb of aluminum per ton of steel and the other without the specific addition of aluminum, has been placed by the Consolidated Gas Electric Light and Power Co. of Baltimore. The two heats ordered by Baltimore will afford opportunity for comparing the merits of both types through laboratory tests and in an actual installation.

In order to maintain reasonable pipe dimensions for higher pressure plants at temperatures of 950 F and higher, consideration is being given to chrome-moly analyses having higher chromium contents than ½ per cent. Ranges of chromium of 0.80 to 1.10 per cent and from 1 to 1½ per cent have been advocated for such service. Among

the chrome-moly steels having composition in these ranges are those covered by the following ASTM specifications: A158, grade P11; A200, grade 1; and A213, grades T11 and T12. Pipe conforming to A213, grade T12, has been bought for a recent extension at Springdale.

The present specification for carbon-moly pipe of the low-aluminum type, ASTM A206-44T, is still available for those who have occasion to use this material. A206-44T is being continued unchanged except for deleting from the title and scope clause the statement that this material is "intended for service at metal temperatures from 750 to 1000 F." The foregoing temperature range will be supplanted by the expression "suitable for high temperature service," thus leaving the way open for codes and designing engineers to set their own temperature ceilings for the product.

The following temperature limits are suggested by the joint EEI-AEIC subcommittee as reasonable operating limits for the various pipe materials:

Carbon steel, low and medium carbon	825 F
High-aluminum carbon-moly (1.5 to 2 lb Al per ton)	900 F
Low-aluminum carbon-moly (0.5 lb Al per ton)	925 F
Chrome-molybdenum (½% Cr—½% Mo)	950 F*

Operating temperature swings should not exceed the above temperatures by more than 25 F.

The suggested temperature limits are based on consideration of service experience exceeding 60,000 hr in the case of carbon steel and high-aluminum carbon-moly pipe as well as laboratory findings to date. The service experience with low-aluminum carbon-moly so far reported is only of the order of 20,000 hr, but laboratory findings confirm its greater resistance to graphitization.

(e) Heat Treatment of Carbon-Molybdenum and Chrome-Molybdenum Pipe and Bends Prior to Installation

Heat treatment at the pipe mill, except by special agreement, consists of a stress-relief anneal by heating at 1200 F followed by slow cooling. Where pipe is installed without subsequent heating for fabrication of bends, consideration should be given to a normalizing treatment. Normalizing low-aluminum carbon-moly pipe and pipe bends by heating to 1750 F and cooling in air has been found to produce a desirable structure from the standpoint of creep resistance. A similar treatment should be suitable for chrome-moly pipe and bends, but the exact treatment to give high creep strength and other desirable characteristics has not been agreed upon.

* Higher temperatures may be found permissible for chrome-molybdenum pipe as far as graphitization is concerned.

An engineer at Battelle Memorial Institute at the Zeiss metallograph used for examining graphitization test specimens

ALBERT KAHN NAMES NEW OFFICERS

Election of Geo. H. Miehls as president of Albert Kahn Associated Architects and Engineers, Inc., to succeed the late Louis Kahn, was announced October 5. The board of directors also named Mr. Miehls, formerly executive vice-president, treasurer. Sheldon Marston, previously vice-president, was elected executive vice-president, and Saul Saulson and O. L. Canfield were named new vice-presidents.

These men, with Robert E. Linton, vice-president, and Geo. K. Scrymgeour, secretary, comprise the executive staff of the organization.

The new officers take hold when the firm has more projects under way than in any previous peacetime year in its four-decade history. These projects represent new post-war construction work for the revitalization and expansion of American industry and commerce.

"Open for Discussion"

SAFETY ON THE JOB

THE EDITOR—Three cheers for the photos and article, Safety on the Job, in the August issue.

I hope that such items will appear at regular intervals. They will help management realize the importance of safety; they encourage the man in the plant to remove hazards.—ARTHUR M. HILL, professor of heat engineering, Tulane University of Louisiana.

DIFFICULTIES WITH SHUTDOWN A.C. SYSTEM

THE EDITOR—We have somewhat of a problem in our air conditioning system that I would like to submit for a possible solution or suggestions.

We have a full expansion system using "Freon" refrigerant, three compressors, two 50 ton and one 40 ton. All lines are copper leading to the top of our 10 story building to a water cooled evaporative condenser on the roof. We have a cooling coil solenoid and expansion valve on each floor controlled from a switch panel in the basement with controls also on each floor. We have, of course, some steel in the system such as hand valves, check valves, condenser shell, receiver, subfreezer, etc.

Our condenser was formerly steel tubed, containing about 212 tubes 1¼ in. OD, 15 ft long; these, however, were replaced with copper this spring.

The system has stood idle for the past two years due to lack of refrigerant. Early this spring we had this system checked for leaks; compressors, valves, etc., checked and cleaned preparatory to charging and operating the system. In the reconditioning process we engaged a local firm to do the work of checking. They used in checking for leaks dehydrated carbon dioxide under 150 psi. The "Freon" lines were apparently 100 per cent atmospheric previous to introduction of the CO_2.

It has not been definitely clarified whether or not the CO_2 was purged from the lines before entering the charge of "Freon"; at any rate, a total of 12 drums of "Freon" was injected and the system placed in operation. After a few days' operation it was discovered that the solenoids and expansion valves were sticking, some open and some closed. A checkup of the electric controls revealed nothing out of order. The valves and solenoids were then replaced on the theory that two years of idleness had caused corrosion, but we experienced the same result—the new valves also stuck.

The compressors were then opened and considerable sediment was found in the crankcase oil. A heavier sediment was also found in the unit strainers. A sample of oil sediment, strainer sediment, and a sample of the "Freon" taken from the liquor line was analyzed, a report of which is given herewith.

The problems with which we are confronted are:

A) Is there a possibility of saving the 12 drums of "Freon" still in the system, now impregnated with CO_2, and if so how can this be done?

B) What is the actual cause of the sediment found in the oil line and strainers, and how can it be removed from the lines, valves, coils, etc.?

C) Is it possible that a chemical action has taken place caused by the mixture of "Freon" and CO_2 that will attack the steel and iron in the system?

D) Will the retention of the mixture in the system for any length of time endanger the system?

Operation has of course been suspended since the discovery of the above conditions. All compressors have been opened up, the contaminated oil removed, and the compressors cleaned.

Any information or suggestions will be greatly appreciated.—J. M. B.

REPLY—Two of the most important concerns in the installation of any "Freon" system are:

1) To be absolutely sure that the piping installation is tight and clean. (It is almost impossible to clean a dirty system.)

2) To be sure the system is thoroughly dehydrated and absolutely free from moisture, which can only be accomplished by the vacuum pump method.

The fact that copper piping is used in the system does not necessarily mean that it has been cleaned; as a matter of fact, if ordinary acid flux is used for soldering the joints, the excess may cause serious internal corrosive action, the byproduct of which will account for the considerable sludge. Although steel tubing or steel pipe is satisfactory, it is usually coated with an oil to prevent corrosion in storage, and unless this oil is cleaned off by pickling or otherwise, before installing, it will be removed by the cleaning effect of the "Freon" and add to the sludge accumulation.

Because of these problems, as well as that of dehydrating, elaborate or extensive direct expansion piping systems present a number of special problems, partic-

Report of Analysis

The sample of "Freon" submitted contains 5.2 per cent of carbon dioxide. The material contained in the small jar consists of iron rust (hydrated iron oxide) such as would be formed by the action of carbon dioxide and moisture on steel pipe.

The sediment in the sample of lubricating oil consists of finely divided iron, probably the result of cylinder wear.

WHEN ENGINEERS gather to hear a paper or talk, there comes a time when the meeting is thrown "open for discussion." We follow this custom in these columns, which provide an opportunity for readers to comment on articles published in HPAC; discuss other topics of interest to heating, piping, and air conditioning engineers and contractors; ask questions, etc. The editors will welcome your remarks. Address Heating, Piping & Air Conditioning, 6 N. Michigan Ave., Chicago 2

ularly where multiple compressors are involved, and therefore, for the larger installations where the air conditioning equipment is remotely located, it has been found more advisable to install a cold water circuit. In other words, the "Freon" refrigerating machinery is installed in a machine room and water is cooled and circulated to the cooling coil. This type of installation is naturally a little more expensive initially, but is far superior from an operating standpoint, since all of the important control items are right in the machine room under the eye of the supervisor. Further, the "Freon" piping is limited to the machine room where it can be frequently checked.

It appears to me that the extensive direct expansion piping on this job made it very difficult to put in a perfectly clean installation. Further, the use of the steel tubes in the condenser undoubtedly added to the quantity of sediment or silt that eventually has found its way to the various strainers. To the sediment that was initially in the system there has been added some more because of the corrosive action of the moisture which was brought into the system either as water or as vapor.

The answers to the four questions listed are as follows:

A) The 12 drums of "Freon" can be returned to the manufacturer for credit, and it will be reprocessed. Therefore, a considerable cost of the "Freon" can be salvaged.

B) The cause of the sediment found in the oil lines has been stated above and is due to the dirt that was initially in the system plus the dirt caused by corrosive action. It may be removed only by continuous cleaning through screens and filters in the liquid line. It probably would be advisable to install a liquid line filter bypass arrangement and alternately replace the filters at regular intervals.

C) It is not only possible but quite definite that corrosion had taken place because of the water, air, and CO_2 and other impurities that had been permitted to remain in the system for some time. There is only a slight corrosive action from "Freon-12" and moisture.

D) The corrosive action will continue as long as the impurities are present in the system.

There will naturally be some cost involved in cleaning the system.—W. B.

TESTING WATERS FOR INDUSTRIAL USE

Several important new specifications and testing procedures for widely used materials accepted by the American Society for Testing Materials' Committee E-10 on standards will be published by the society during the fall, and will be included in the 1945 supplement to the Book of Standards which will be issued late in December.

Committee D-19, on water for industrial uses, has issued several standard methods of determining various elements and ions in industrial waters and the three new methods accepted by the society cover total aluminum and aluminum ion in industrial waters (D 857), manganese (D858) and silica (D859). In general these methods are intended to provide procedures from which the quality of water may be judged and to control water treatment operations. The method for silica is particularly important in boiler operations so that measures can be taken to prevent the formation of complex silicate scales and to reduce the tendency of the "embrittlement" of boiler metal. The new tentative recommended practice for sampling boiler water for stationary boilers (D 860) is another phase in the program to establish recognized methods for sampling in order to obtain the necessary analytical information to judge the quality of water.

Numerous technical papers and reports have covered procedures for testing for dissolved oxygen, and after considerable study the subcommittee concerned proposed a standard test which included a method for referee and three nonreferee procedures. The method of highest precision and accuracy was intended for acceptance testing of deaerating and for research testing of power plant equipment. It is essentially the so-called Navy method which has been described in papers by Dr. R. C. Adams and others. Non-referee method B is based on the Schwartz-Gurney method as modified by Ulmer.

In the referee method it is indicated that a skilled operator can obtain a precision of 0.002 ppm and with an accuracy of 0.003 ppm or 1 per cent, whichever is the greater. Precision for the nonreferee methods ranges from 0.004 ppm to 0.05 ppm of the true values. Because of numerous comments and some negative votes, it is planned to publish the proposed methods as information and for comment in the ASTM Bulletin. All those concerned are invited to study the methods and submit comments to committee D-19 for consideration.

CONSTRUCTION VOLUME CONTINUES UPWARD

Construction volume in the 37 states east of the Rocky Mountains continued to mount in September. Outlays for construction involved in contracts awarded during the month were 5 per cent above August and 58 per cent above September of last year, according to tabulations of individual project contracts reported by the F. W. Dodge Corp. The total valuation of September contracts was $278,262,000.

Nonresidential construction featured the month's activity, with substantial gains over the previous month and over the corresponding month of last year. Ninety-five per cent of the nonresidential awards were for private accounts, only $8,511,000 of a total of $181,033,000 being classified as publicly-owned. The record for the first nine months of this year shows 57 per cent of all nonresidential construction was for private accounts compared with only 25 per cent during the corresponding period of 1944.

Residential construction in September continued at the August level with a total of $42,580,000. This volume was 74 percent above that reported for September 1944.

The dollar volume of all construction for the first nine months totaled $2,281,960,000, a gain of 52 per cent over the corresponding period of last year.

...on Operation, Maintenance, Repair, Alteration, Extension

What Good Is a Valve If It Doesn't Work When Needed?

THE HOUSE pumps which deliver water to the roof tank of a tall office building required overhauling a while ago. The suction and discharge valves for the first pump were closed, but opening the test valve (air petcock) showed that the pump was still under pressure. Suspecting that the discharge and check valves were defective, the engineer drained the line leading to the roof but could not stop the flow of water. It developed that street pressure was forcing water through the suction valve, and it was necessary to shut off the valve in the street main in order to plug the suction line while the valve was being repaired. Similarly, the discharge line had to be plugged so that service could be maintained with the alternate pump while the discharge and check valves were being overhauled. The same procedure was followed in order to repair the other pump. The defective valves meant considerable extra time, including overtime, and substantially increased the cost of the pump job.

In another building three successive leaks occurred, two on the downfeed water risers and one on a galvanized roof tank feed line which developed a split about 2 ft long in a concealed pipe shaft. In all three cases, shutoff valves were provided. The riser shutoff valves closed satisfactorily, but the main valve would not stop the flow of water, and considerable damage was done to plaster and to a special piece of electrical equipment which was being used for war work. Service was restored by disconnecting the line at the house pump and welding a temporary connection into the downfeed line leading to the hot water tank in the basement, and using this pipe for feeding the roof tank as well as the hot water tank.

The load on the private generating plant in a factory building increased during the war. Steam was generated in four water tube boilers which formed a battery. Four similar boilers were located opposite these, connected to a separate steam main which could be used to supplement the boilers in use. It was decided to prepare one of these spare boilers for service, but tests showed that practically all of the valves were inoperative. The smaller valves, such as the feed and blowdown valves, were renewed and the larger ones, such as the main non-return stop valve, were overhauled. However, to use the steam header it would have been necessary to overhaul all the valves leading to and from it, so that it was considered better to abandon its use and run a new 6 in. line across to the header already in service. This avoided losses through leaking valves, as well as condensation losses in the second header and connections.

Examples could be multiplied out of the experience of every engineer of times when valves which were counted on to function in an emergency failed to close tightly, or perhaps could not be turned even with a wrench. Valves are the keys to the bloodstreams of a building, and are installed at points where it is expected they may at some time be found useful. If they are allowed to deteriorate through mis-use or dis-use they will not serve their designed purpose when the need arises. It is therefore just as important that they be maintained in good operating condition as to have them installed at strategic locations.

Use a Valve Chart

It is also essential that building operators know the position and function of each valve in order that

Lewis W. Mauger, Supervising Engineer, Brown, Wheelock, Harris, Stevens, Inc., Stresses Need for Maintenance Program

it may be maintained and properly used. Valve maintenance begins with the valve chart on which all valves are shown and numbered to correspond with the number on the valve tags. (This would not include minor types of multiple valves such as basin, shower, or radiator valves.) In addition to the listing of the valves, diagrams should be posted showing the various fluid systems schematically, including the hot and cold water systems, the heating and return systems, sprinkler, fire line, refrigeration, sewage ejection, compressed air, or any other system in which valves are employed. The architect's plans should be available for the building operator, and all subsequent changes should be noted on them.

A regular program should then be instituted for exercising and testing valves—even at the risk of disturbing the packing and causing leaks which may mean repacking. The stems—particularly of rising stem, and outside stem and yoke valves—and the exposed parts of iron valves which are subject to moisture or condensation should be lubricated or the metal otherwise protected against corrosion. Exercising should be done with the line in service so that the flow of the liquid or gas will assist in the removal of rust, scale, or other foreign matter which may prevent tight closing. Gate valves set with their stems downward are less apt to become fouled by deposits than with their stems vertical.

If a valve is found to be defective, it should be opened, cleaned and examined. Often the cure can be effected by renewing the disc, gate or seat. When these parts are not of the renewable type or when they are not available, it is usually possible to grind in or reface them. For small valves and faucets, reseating tools may be used effectively. For larger valves such tools are rather expensive so that only a large plant or a firm specializing in such work would be justified in purchasing them. Other conditions may be responsible for failure to hold tight, such as bent stem or other parts, holes in the metal, improper design for the service, wrong packing, etc. It is obvious that repairs should be made even though the leak is small, since continuous wiredrawing is apt to eat away the metal rapidly—perhaps to a point beyond which repairs are impossible.

Testing Pressure Reducing Valves

Attention should also be given to other types of valves to make certain they can be depended upon to perform their functions properly. Check valves which do not close because of corrosion, foreign material, or warped or missing discs may cause a considerable power loss in a hydraulic system, a substantial water loss in a supply system, or the cracking of a boiler in a steam heating system. Too often, checks are not examined or tested until serious trouble develops and the smaller losses have been sustained over long periods. Listening for a flow through a check and watching for a change in pressure on a gage provide easy methods of ascertaining effectiveness of a check.

Pressure reducing valves can be readily checked by pressure gages which should be installed on the discharge side not too close to the valve, or on the equalizing line. Exceptions would be reducers such as might be used on branch water lines or fire hose outlets. Reducing valves should be tested at full, partial, and no flow and possible different inlet pressures to determine their accuracy under various working conditions. If the discharge pressure builds up with no flow, a deadend shutoff is not being effected. This may be the most important phase of the test, since if the reducing valve is depended upon to prevent a build up beyond a certain point it must close tight.

In steam systems, reducing valves are sometimes employed as shutoff valves by closing them mechanically or otherwise. A tight stoppage of flow is essential for this purpose, both for the operation of the system and to prevent continuous condensation of steam beyond the valve during off periods. If double seated valves are used because of their ease of opening and closing, special care must be taken in their maintenance. When they are reground, they should be heated to normal operating temperature to equalize expansion of the spindle and body. Diaphragms of the proper material and weight should be stocked for replacements. Steam which might vulcanize or warp diaphragms should be kept away by maintaining a water seal in the equalizing line.

Radiator valves of the packed type should be repacked every second summer, while those of the bellows type should be tested to determine if they close properly. Defective bellows will cause loss of vacuum besides annoyance to occupants through inability to shut off steam. Discs and seats can be examined when the bonnets are removed.

"VALVES ARE THE keys to the bloodstreams of a building," says the author, and if valves are allowed to deteriorate through mis-use or disuse they will not serve their designed purposes when the need arises.

Refacing tool for wedge of a gate valve in operation

Modernized Piping and Heating Services Aid Plant Efficiency

Harry M. Nobis, Power Plant Engineer, The Warner & Swasey Co., Describes Piping and Other Changes Which Lead to Savings at Big Plant

WHEN the size of a factory is to be increased because of new production demands, or its layout revised to provide different production facilities, the piping and heating services must be carefully analyzed and made up-to-date to meet the changed conditions. An analysis of this kind will frequently bring to light things which might well have been corrected years ago, even without any question of expanded or changed production facilities. Thus, it is essential to efficient industrial operations to study the piping and heating systems serving a factory which is converting from wartime to peacetime production—just as it was when conversion was in the other direction. It is equally essential from time to time to give thought to the piping and heating facilities for a factory which is not being "converted," but which is going along in more or less routine manner, to be sure that these important services are being furnished in the best and most economical way possible in the light of today's developments in engineering and equipment and today's requirements. In such an analysis, the overall picture must govern and the relationship of the piping, the heating, and the other plant facilities to each other must all be considered.

A case in point is the heating and compressed air installation of our machine tool plant, which contained, prior to the war, about 4,723,000 cu ft of space, and which was soon increased to 11,208,000 cu ft. There were about 38,000 sq ft of radiation in the old building, and with the new additions the total became more than 125,000 sq ft.

In the summer of 1941, the four old water tube boilers were removed and two modern steam generators were installed in a smaller space. The new boilers are of the integral furnace type; each has a rating of 27,600 lb per hr of steam at 140 psi working pressure. The bituminous slack coal is fired by single retort hydraulic unit stokers, the combustion air is furnished by two steam driven turbine blowers equipped with floating draft controls, and the ashes are removed by a steam ejector. Complete instrumentation is provided.

The old boiler room appurtenances were largely retained, with the exception of the boiler feed pumps and the chimney.

The old heating plant was served by the exhaust steam of a 300 hp steam engine, driving a d-c generator. This equipment has been in use since 1906 and could supply about 7600 lb per hr of exhaust steam. (The exhaust steam distribution piping will be referred to as the "base" steam line). About 4000 sq ft of old radiation had been disconnected from the base line and connected to a new 40 psi steam line, the condensate of which discharged directly into the return line of the base line.

WHEN EXPANDING or converting industrial plant facilities, the importance of the piping and heating services and their relationship to the overall efficiency of manufacturing operations should not be overlooked. The same is true of any factory, whether or not conversion is a question, and it is well to analyze the piping and heating systems in the light of today's engineering and equipment developments and today's requirements. . . . Mr. Nobis describes here some of the piping changes at a large plant, and the advantages that have resulted from them.

The new buildings are supplied by boiler pressure with reducing valves near the center of the heated areas. A pneumatic system of temperature control is connected to about 97 per cent of all radiation.

The operation of the old steam engine was wasteful from all angles. The cost of intermittently generated electric current was higher than purchased current; from 20 to 75 per cent make up water was required to replace the wasted exhaust steam, which the base steam line could not condense in 90 per cent of the heating period. The oily return condensate gave serious trouble to the new steam generators.

The condensate from all the heating systems is returned to the surge tank in the boiler room by three duplex vacuum pumps.

Excessive Boiler Blowoff

With the engine made inoperative and all the direct-to-sewer connections changed to visible drains, the daily make up water required amounted to more than 4000 gal. Part of this loss was caused by the necessary excessive boiler blowoff, due to the internal feedwater treatment used. This internal treatment created a muddy saturation, the excess of which retarded heat circulation and heat transfer. The high heat transfer efficiencies obtained by these modern steam generators rests entirely on the speed of the water circulation. The presence of billions of dirt molecules retards the formation of small steam bubbles, so essential in maximum steam generation. The boiler water line is not steady and large carryover occurs as soon as the steam demand increases.

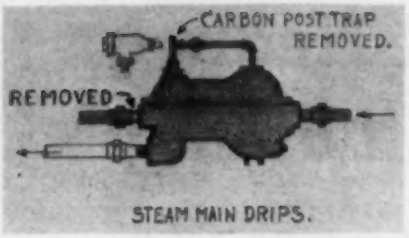


Fig. 1—The two drip traps on the end of the base steam main bled directly into a 4 in. return main

The constant attrition between the particles and the impact against the tubes produced a superfine conglomeration which defies an accurate chemical analysis. These particles would not settle in the lower drum, and hence the top blowoff was used. In March 1943 both boilers were on the line because one boiler could not carry the load, but after removing the impurities—as later described—one boiler delivered more than 31,000 lb per hr of steam, for short periods, in the 1944-45 season.

The reasons for further condensate losses are shown in Figs. 1, 2, 3, and 4, the shaded areas in these details indicating the old conditions and the plain areas illustrating the new conditions. The two drip traps (see Fig. 1) on the end of the base steam main had been installed some 30 years before, and bled directly into a 4 in. return main within 200 ft of the vacuum pump. This caused a zero vacuum some 1200 ft distant, as shown in Fig. 2. To obtain some return line vacuum at the two 15 hp operating vacuum pumps, cold city water was injected, as shown in Fig. 3. The undersized surge tank in Fig. 4 could not store the water volume returned from the entire heating system, hence the sewer was seldom dry. The remedies applied are indicated in Fig. 5, on which are shown the enlarged surge tank, with an electric water level control float switch, No. 3, which actuates the solenoid valve, No. 5, in the basement. The water meter, No. 6, gives a daily check on the volume of water used.

Coal and Water Saved

The average make up water volume for 270 heating days during the 1944-1945 season amounted to 1205 gal per day, or about 3 per cent plus of the total steam generated. The warmer make up water used saves about 9 tons of coal and the water saving amounted to $42 for the season. Only one pump is used now and the temperature of the condensate ranges between 140 to 150 F. To insure low temperature returns, the flash steam from the 40 psi steam main drips, and from some unit heater returns, is put to work in other unit heaters near large door areas.

The surge tank receives all condensate through the vapor and air separating lock, which is vented through pipe No. 14 on Fig. 5. The slanting and horizontal decks provide a catch area for the larger

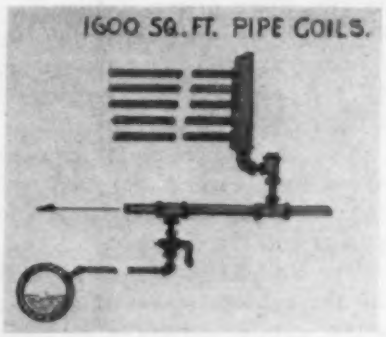


Fig. 2—The absence of a vacuum at these coils required the waste of good condensate to the sewer

solid impurities. The slanting cloth filter, a later addition, retains floating oily scum from the old exhaust steam and return lines. The old oil drum, No. 7, stores some of the warm water from the air compressors. The electric water conditioner, No. 18, prevents the formation of hard silicate deposits in the air compressor coolers, etc. The small amount of electric current used removes the cementing action from the water solids, leaving a soft deposit. The oil separator, No. 8, serves the boiler feed pump. The clean turbine exhaust formerly was contaminated by the oily pump exhaust.

A small amount of emulsified oil remains in the feedwater and is beneficial to the boilers. This oil within the boiler attaches itself to the finer floating particles, forming mud balls which are deposited in a non-circulating area of the lower drum. I regard this oil and mud "marriage" as a distinct advantage, provided the oil is in light concentration. Daily water samples are obtained in 1 gal bottles, and judged for clarity. After several days of settling, no oil color reflections appear on these samples.

The low pressure condensate lift pump, No. 9 in Fig. 5, formerly received the high and low pressure steam drips, in the basement area. Operating difficulties and noise made it advisable to drain the high pressure drips direct to the feedwater heater.

A novel deaerating system was installed in the summer of 1944 for the following reasons:

Large, rusty, barnacle deposits had accumulated in the boiler feed line and in the cast iron valve chambers of the pumps, in two heating seasons. This condition indicated that the rust producing gases had not been removed from the water despite the constant release of a 1 in. vent pipe. The feedwater temperatures ranged from 214 to 220 F.

In steam heating systems, the production and cumulative reproduction of iron oxides of porous particles is taking place constantly. These porous materials acquire gases by absorption, which is aptly defined by Webster as follows: "A common phenomenon consisting in the adhesion of the molecules of gases or dissolved substances to the surfaces of solid bodies, result-

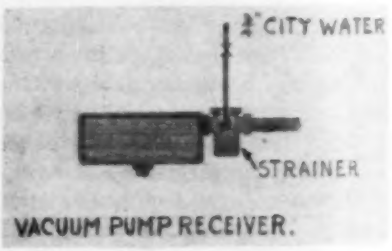
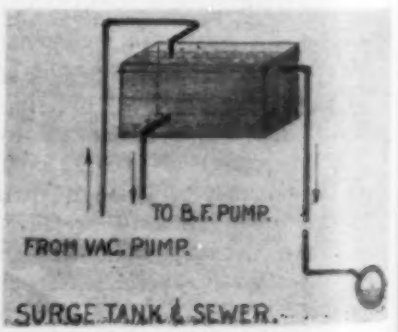


Fig. 3—To obtain some return line vacuum at the pumps, cold city water was injected

Fig. 4—The under-sized surge tank could not store the water volume returned from the entire system



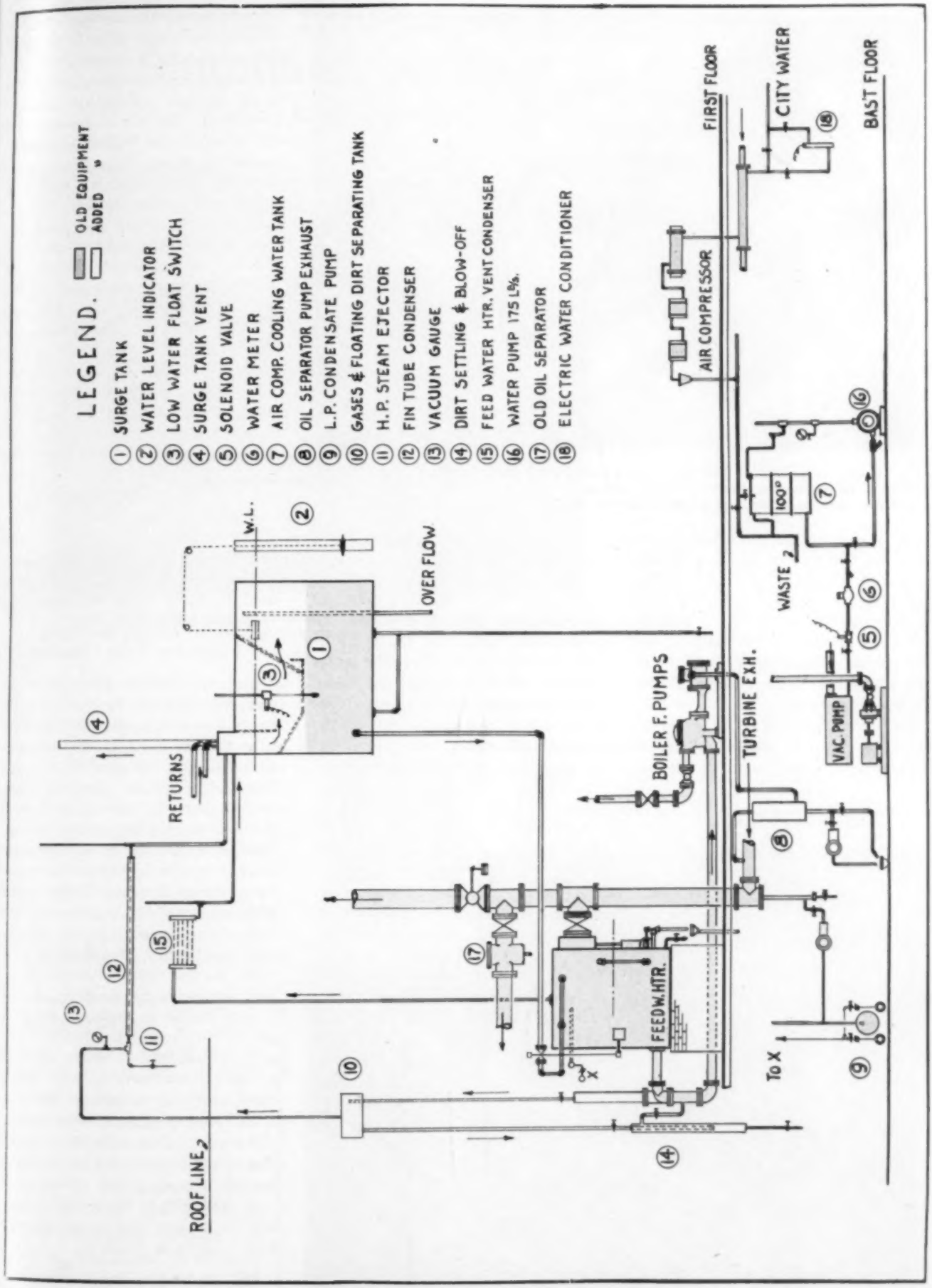


Fig. 5—The remedies applied are indicated here, including the enlarged surge tank, with an electric water level control switch which actuates a solenoid valve in the basement

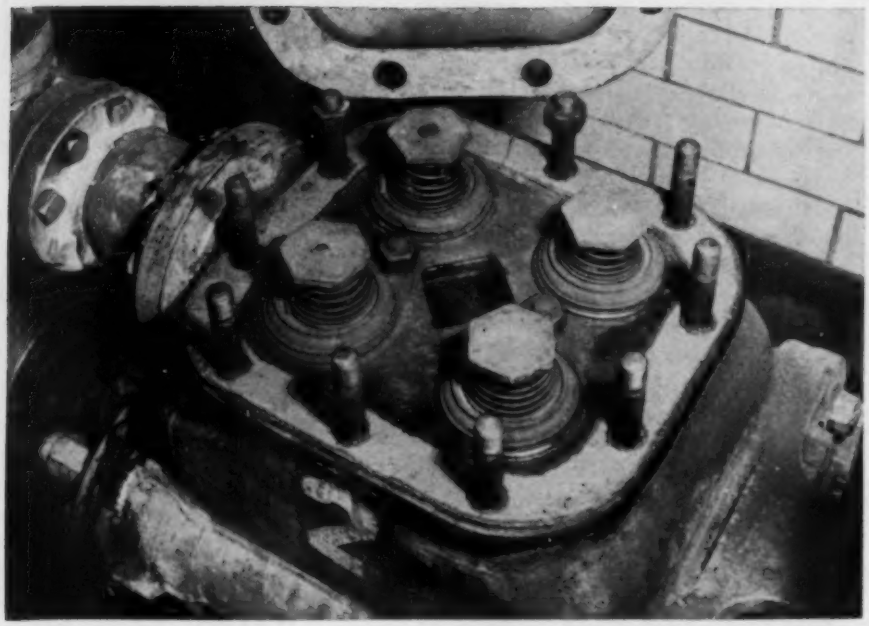


Fig. 6—An inspection of the boiler feed pump heads and the pump valve areas, after a season's use, showed clean surfaces. The valve seats were perfect, showing that no solids had passed between the seating areas

ing in a relatively high concentration of the gas or solution at the place of contact." A large portion of this dirt floats, depending to a great extent on the flow velocity of the condensate. The suction end of the boiler feed pumps is the area of slowest velocity and facilitates barnacle growth.

I have found that free gases and gas laden dirt can be removed from liquids by means of lower pressures. This operating principle is shown in Fig. 5, wherein the separating tank, No. 10, must be not less than 14 ft above the water column established by the usual back pressure in the heater. The suction line to the air ejector, No. 11, produces about 12 in. of vacuum. By maintaining a progressively increasing lower pressure above the pump suction connection of the heater, any free air or gas-charged dirt rises to the higher level with increasing speed. This gas-charged dirt hits the top of the tank and is exploded by the impact. The resulting mud, having lost its buoyancy, sinks to the settling chamber, No. 14, for removal. The bypass leading from the upper part of the settling chamber to the pump suction line insures constant circulation aided by the temperature drop between the flow and return lines.

A recent inspection of the boiler feed pump heads and the pump valve areas, after a season's use, showed clean surfaces. The valve seats, Fig. 6, were perfect, indicating that no solids had passed between the seating areas.

The atmospheric steam condensers, Nos. 12 and 15 in Fig. 5, save condensate. Most of the material used to build them was recovered from the scrap pile.

Table 1—Steam Plant Operating Record

Building volume, cu ft	11,208,000	11,208,000	11,208,000
Heating season	1942-1943	1943-1944[a]	1944-1945[b]
No. of heating days	No record	237	270
Degree days[c]	5,849	5,878	6,026
Tons of coal used	5,231	4,356	4,788
Average lb of coal used per cu ft	0.933	0.777	0.854
Average lb of coal used per degree day	1,788	1,482	1,589
Average tons of coal used per heating day	No record	18.39	17.73
Total make up water, gal	No record	No record	325,350
Average make up water per day, gal	No record	No record	1,205
Boiler compound used	$914.00	None	None[d]

[a]Added 9800 sq ft EDR.
[b]Added process steam for heat treat department, kitchen, and hot water.
[c]Fenn College weather station.
[d]Professional chemist water testing $100.00.

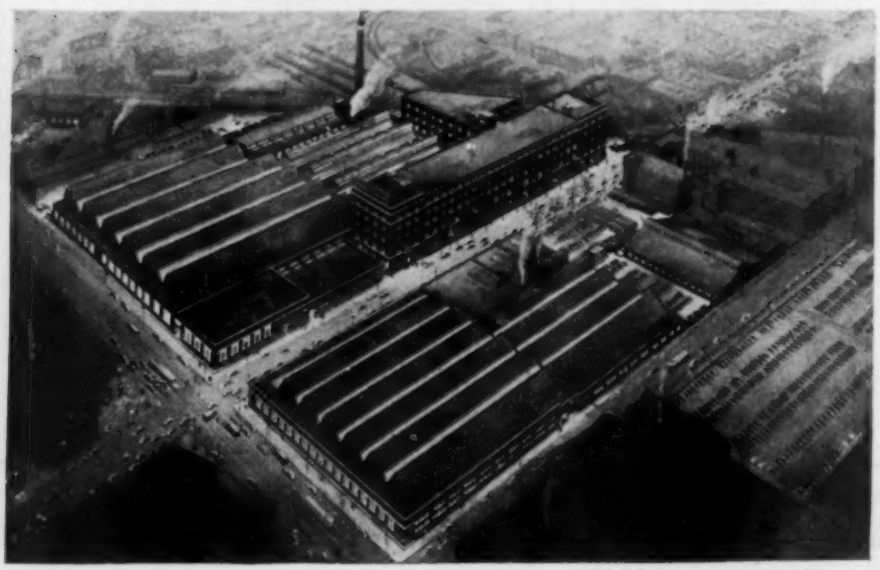


Fig. 7—General view of the plant

Pump for Tube Cleaning

The centrifugal pump, No. 16, was installed to furnish 160 psi water pressure to operate the boiler tube turbine cleaner. It formerly took 20 days, 160 tons of coal, and city water to clean the scale from both boilers by operating one of the boilers and boiler feed pumps. This new method of cleaning the boiler tubes costs less than it would have cost to clean one boiler and in addition saved 176 man-hours. The cost of the complete pump installation and piping amounted to $350.

We do not require the pump for any further tube cleaning, but it is very useful to wash out the boilers at the end of the heating season, to wash out the water channels of the air compressors, and also to wash the roof areas of the sawtooth buildings that receive the dirt and cinders of an adjacent railroad. The pump is mounted on a skid to facilitate moving it to other areas.

A summary of the yearly operating items covering steam generation is given in Table 1.

Piping, Equipment Maintenance Simplified by Welding Process

Francis A. Westbrook Reports Brewery Experience

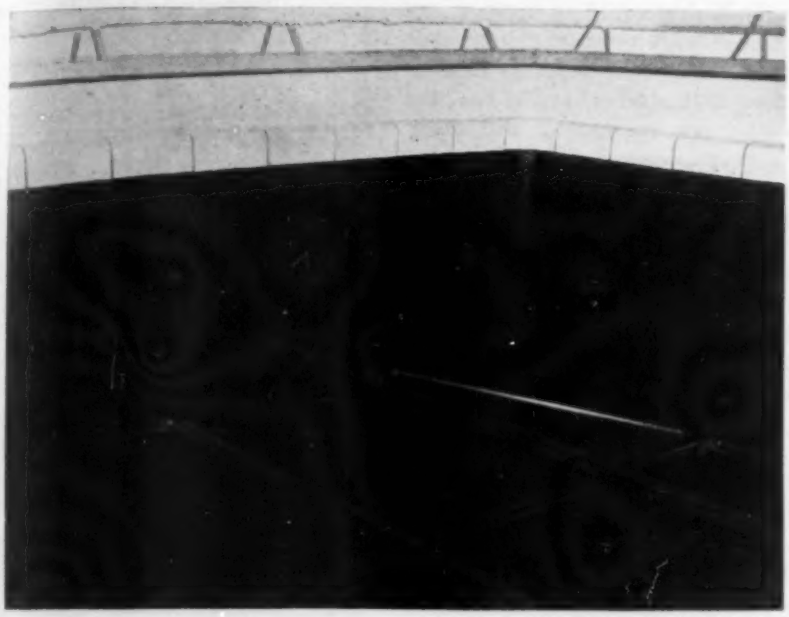


Fig. 1—One of the first uses the brewery had for its welding machine was to weld steel pipe for circulating refrigerant to cool beer

EXPERIENCE OF THE welding department of a prominent brewery furnishes an example of the merits of welding in maintenance work. The superintendent has said that the purchase price of the arc welding machine was saved in 30 days by the repair and other work it enabled him to do. With the still-existing shortage of parts and equipment used in industrial plants, this experience shows how welding can be of very substantial benefit.

Construction and repair work on much of the piping, certain tanks, conveyor supports, and many other items of equipment lends itself especially well to arc welding. It can be used for the repair of localized breaks and frequently saves much time and expense because it makes unnecessary the dismantling of machinery and other equipment, and avoids long delays. It has been demonstrated that reclamation by such means results, in many instances, in replacements that are stronger, smoother, and longer lived than the original parts.

MAINTENANCE of piping and other equipment in plants and buildings is facilitated in many ways by using the welding process. The superintendent of a prominent brewery, whose experience is summarized here, reports that the purchase price of an arc welding machine was saved in 30 days by the repair and other odd jobs it enabled him to do.

One of the first uses that this brewery had for its welding machine was to weld a steel pipe for circulating refrigerant to cool beer during the fermentation process. All of the joints for the entire length of this pipe were welded and it is held in place inside the vat by welded connections (Fig. 1).

Another use made of welding was in the construction of an air pressure grain conveyor from railroad cars to storage and from storage to mash tubs by means of large diameter pipes. All seams are welded. The grain is blown through the pipe at such velocity that the wall on the outer portions of curved sections wears thin due to the abrasive action. This is taken care of by welding a strip of 2 in. by $\frac{3}{8}$ in. flat steel bar stock to the outer surface of the pipe, as shown in Fig. 2.

The maintenance department has also used welding for steam and water piping as well as for numerous other items made of structural steel throughout the plant. The permanence of such work naturally reduces future maintenance

Fig. 2—A steel strip is welded to grain conveyor pipe to reinforce it at the turns

Fig. 3—Welding was used in reinforcing columns by means of split pipes

and interferences with production schedules.

Welding was also used for floor reinforcement by means of welded pipes. The brewery power house is on the first floor. The upper floors and roof were originally supported by four cast iron columns extending up four stories; additional load due to new machinery and other equipment necessitated strengthening of the columns. This was done by obtaining some 18 in. pipe and splitting it longitudinally. The two halves were then placed around the cast iron columns and welded together. The space was then filled with concrete and a strong support was secured at low cost, as shown in Fig. 3.

Another concern used old boiler tubes 4 in. in diameter to make columns for supporting the roof of a new warehouse. Two tubes were welded together to make a column and top and bottom baseplates ½ in. thick were welded to the ends, the top plate being welded to the roof trusses. Eighteen columns were made in this way. In another instance, hot air ducts were fabricated by welding scrap metal.

All of the jobs mentioned can be done by the plant maintenance gang and the extent to which welding can be used seems to depend to a great extent on the imagination and ingenuity of the plant engineer or master mechanic.

VICTORY LOAN

Surveys Air Conditioning Industry

The potential demand for air conditioning is huge, and the industry should do one to one-and-a-half billion dollars worth of business over the next five years in addition to an annual replacement market of $350 million, according to a survey by S. M. Ahmed, of Hirsch & Co., members of the New York Stock Exchange. The report presents graphic patterns of the air conditioning market from early years to the war period, and a projection over the next five years. The data were collected from manufacturers, distributors, government agencies, and trade associations and publications.

In surveying the growth of the industry, the study shows that in the three prewar years, 1939-1941, air conditioning was proceeding at a rapid rate. The number of residential installations increased 114 per cent, commercial 118 per cent, and industrial 143 per cent, Mr. Ahmed states. A comparison included in the report reveals that air conditioning had gone farther in the 10 prewar years than refrigerators, radios, washing machines, electric ranges, and automobiles went during their comparable period of growth.

Despite these impressive gains in new installations, the saturation point is still in the distant future. Mr. Ahmed's data reveal that 22,000, or fewer than 1 per cent, of homes heated with central units valued in excess of $12,000 had air conditioning units installed. Only 3 per cent of department stores, 3 per cent of doctors' and dentists' offices, 2 per cent of bank establishments, 2 per cent of drug stores, 6 per cent of restaurants, 4 per cent of beauty and barber shops and 5 per cent of hotels are air conditioned. Many other markets have been barely tapped.

Forecasting future potentialities, the report points to the replacement market which would develop. Even now replacement is looming as a large factor, it is stated. Some 35 per cent of commercial and 40 per cent of industrial installations were made more than 15 years ago. In addition, the pent-up demand from civilian sources, which were unable to obtain air conditioning equipment during the war, is so great that a backlog equal to three or more years of normal demand has developed.

The study lists some of the favorable factors in the growth of the industry: (1) the public is becoming increasingly air conditioning minded; (2) sale of equipment is self-expanding, i.e., one sale leading to another through direct competition among users of equipment; (3) essentiality of air conditioning in numerous manufacturing processes and in the preservation and processing of food products; and (4) better equipment offering improved performance and operating economies.

The rapid growth and prospects for large volume of peacetime business have enabled air conditioning to attain an important place among the nation's industries. The value of total installations before the war, according to Mr. Ahmed's estimates, exceeded one billion dollars. Investment in manufacturing facilities is put at $100 million. There are nearly 100,000 workers employed with a payroll of over $200 million.

Of the billion dollar business in the next five years, according to Mr. Ahmed's study, commercial users for comfort purposes, such as restaurants, stores and offices, would account for 50 per cent, industrials for manufacturing purposes 25 per cent, residentials 13 per cent, and the balance equally divided among theaters, public buildings, and railroads.

Sam Lewis' Page

A READER of HPAC has asked for comment on the following problem:

A shipping door in a large shop is 10 ft wide and 10 ft high. Just inside the shipping door is an open hatchway through to the second story. Cold air enters when the shipping door is opened. It is not practicable, due to the hatchway, to install a warm air duct across the top of the shipping door with a slot in its bottom to deliver warm air downward in an attempt to create an invisible barrier.

The question is asked as to whether a blast of warm air delivered diagonally across the shipping door would justify itself, and—if such an air curtain should be installed—at what velocity and volume should the air be introduced?

Reasonably satisfactory results have been attained in cases like this by installing an ordinary propeller type unit heater say 12 ft inward from the shipping door, with its diffusing vanes adjusted to deliver the warm air diagonally downward toward the door. An average warm air velocity over the entire 100 sq ft of door opening of 30 linear fpm should be reasonable, requiring a unit heater rated at 3000 cfm of air.

A door switch might be installed at the door so that the electric circuit to the fan motor will be opened, stopping the fan when the door is completely closed but causing the fan to run as soon as the door commences to open.

Another scheme might be to install a vertical duct at one side of the shipping door, if there is room, this duct having a slot 3 in. wide from the floor to a level about 8 ft above the floor, discharging the air horizontally across the door opening and parallel with its plane when closed. A unit heater with a centrifugal fan should be installed, since there will be considerable resistance.

If 3000 cfm is to be delivered through a slot 3 in. wide and 96 in. high, the slot will have 2 sq ft area and the air velocity at 3000 cfm through the slot will be 1500 linear fpm, which should force an acceptable curtain across the doorway.

In either case the unit heater should be of the recirculating type, with output equivalent at 60 deg air inlet temperature to about 640 sq ft of steam radiation.

THIS IS a plea for temperance—in the sense that temperance is habitual moderation. Perhaps appreciation of temperance is an idiosyncrasy of the elders based on their long experience; and I am probably an elder.

Habitual moderation in many engineering practices seems to be on the increase. The following are some examples of "temperance" in engineering which I have recently noticed:

1) Noticeable records of fuel economy are being obtained by employing relatively cool heating surfaces warmed by water vapor at subatmospheric pressure or by moderately hot liquid.

2) Cooling of crowded workrooms is being accomplished most satisfactorily with large volumes of air at introduction temperatures much less than 20 deg cooler than the ambient air already in the room. A very successful comfort cooling system maintains 85 deg dry bulb but compensates by a low relative humidity.

3) Electric heating is being applied satisfactorily and economically with large warm surfaces rather than with red hot wires. For example, formation of ice in subway entrances is being prevented by warm electric cables buried in the concrete.

4) Illumination is being provided with glowing gases, as in fluorescent tubes, rather than with incandescent bulbs. Thus there is much less surplus heat to remove, and spot-lighted showcases in stores are not hot to one's hand.

5) One notes in reading architectural magazines describing new educational buildings that few buildings fail to utilize, in at least some of the rooms, radiant heating provided by hot water pipes imbedded in masonry floors or in the plaster of the ceiling.

6) There seems to be a tendency for ventilation air to be introduced through large areas at low velocity rather than to encourage the dust accumulations caused by reaction currents that accompany high velocity air inlet.

7) We approach the use of baseboard type heat transmitters running along the sides of rooms close to the floor.

8) If we do not heat water to a temperature beyond the critical range where entrained solids must be precipitated, there is reduction in maintenance cost. This is an interesting and profitable application of temperance.

9) Probably we do not encourage alcoholic temperance by freezing ice cubes, but we do promote economy in postwar ice-making plants by freezing the cubes directly as cubes rather than by freezing large cakes that have to be sawed into cubes.

10) If many participants support a church by small individual contributions, that church is happier and more effective than the one that lives by recourse to massive endowments. The biggest church row I remember occurred over the details of construction and decoration for a new building that had been donated by one man.

11) My language on a rainy Monday morning when beset by a few interruptions can be intemperate. I realize that I feel conscious of well-being when I control an outburst and force a smile.

IN THIS regular feature, informal comment on heating, piping, and air conditioning problems is given by Samuel R. Lewis, consulting mechanical engineer, and a member of HPAC's board of consulting and contributing editors.

MEETINGS & CONVENTIONS

ASME Schedules 1945 Annual Meeting

The 1945 annual meeting of the American Society of Mechanical Engineers will be held at the Hotel Pennsylvania, New York, N. Y. the week beginning Sunday, November 25. There is some question regarding Thanksgiving Day as the New York law designates the fourth Thursday of November as that holiday and a similar law has been passed, for federal purposes, by Congress.

Among the many divisions sponsoring sessions, the consulting engineering group is planning a round table discussion, the heat transfer division will sponsor two sessions, and the industrial instruments and regulators division will hold three meetings on Tuesday.

The ASME headquarters are at 29 W. 39th St., New York 18, N. Y.

ASRE Plans Annual Meeting

The 41st annual meeting of the American Society of Refrigerating Engineers is scheduled for December 10 through 12 at the Hotel Pennsylvania, New York City. This is the first time since last December that ASRE members have been able to get together on a national scale as the June spring meeting was cancelled because of ODT regulations.

Four technical sessions beginning the afternoon of December 10 have been planned by Charles S. Leopold, national vice-president and chairman of the program committee. Special entertainment features are being arranged by the New York section of the society under the leadership of Chairman Paul B. Christensen. The headquarters office of the ASRE is at 40 W. 40th St., New York 18, N. Y.

ASHVE Annual Meeting Announced

The 52nd annual meeting of the ASHVE has been scheduled for January 28-30 at the Hotel Commodore, New York, N. Y. The ASHVE Journal Section in this issue contains additional information about this important meeting. A. V. Hutchinson, 51 Madison Ave., New York 10, is secretary of the ASHVE.

National Metal Congress To Meet in February

The National Metal Congress and Exposition will be held in the Public Auditorium, Cleveland, February 4-8, 1946, according to word received by the American Welding Society. No official action has been taken on AWS participation as yet, but it is suggested that members planning to attend make reservations early because of the limited number of hotel rooms. There will be no housing bureau, so reservations must be sent direct to Cleveland hotels. When hotels are full, they will turn over excess reservations to the Cleveland Convention & Tourist Bureau for assignment to private homes, if desired.

Midwest Power Conference in April

The annual Midwest Power Conference, sponsored by the Illinois Institute of Technology, will be held April 3, 4, and 5 at the Palmer House, Chicago, Ill. The director of the conference is Stanton E. Winston, Department of Mechanical Engineering, Illinois Institute of Technology, 3300 Federal St., Chicago 16, Ill.

Corrosion Engineers to Meet In Kansas City, May 1946

The National Association of Corrosion Engineers, Southern Standard Bldg., 711 Main St., Houston 2, Texas, has announced dates of May 7, 8, and 9 for its 1946 annual meeting and convention, which will be held in Kansas City, Mo., with headquarters in the President hotel. In addition to the technical programs covering the three days' session there will be an exhibition of corrosion-resistant, corrosion-mitigation, and protective materials in the municipal auditorium.

Technical sessions are scheduled for the same building and in such additional space as may be required to accommodate the sectional and group meetings. The program as outlined includes papers on corrosion practices as developed in representative industries, such as power plants, waterworks, transportation companies, buried communication lines, refineries, chemical manufacturing and processing plants, and oil pipe lines. Simultaneous sessions are scheduled to permit coverage of the program within the allotted time.

Marine Exposition

The National Marine Exposition, sponsored by the Propeller Club of the United States, will be held in Grand Central Palace, New York, N. Y., May 20 to 25. Arthur M. Tode is chairman of the exposition's advisory committee which is made up of members of the club's advisory committee, and other executives in the maritime industry.

Three floors of the Palace will be used for the exposition which, it is said, will be of interest to the average person as well as the marine expert. During the war dozens of industries contributed new developments to shipbuilding and many of these will be on display. New processes and products, new methods, alloys, plastics, fibers, minerals, chemicals, and modern adaptations of old and standard materials such as rubber, wood, felt, and leather will be displayed. It is expected that some unusual developments in electronics will be shown.

The exposition will be under the management of National Marine Expositions, Inc., 17 Battery Pl., New York, N. Y.

* * * * *

If you are planning to attend a meeting or convention, it is suggested that you write the headquarters office of the sponsoring society or group for a copy of the program, and information about hotel reservations, etc. The street addresses of the various societies are given above for this purpose. Sometimes the dates or complete plans for such meetings are changed, and it is well, before making your own arrangements, to check with those in charge of the affair to be sure that no such changes will affect your own schedule. The editors of Heating, Piping & Air Conditioning will be glad to forward your requests for more information to the various societies, if it is more convenient for you to write direct to us.

Heating, Piping & Air Conditioning

AMERICAN SOCIETY of HEATING and VENTILATING ENGINEERS

Journal Section

Suspended Particulate Matter in New York City Air†

Part IV of Air Pollution Survey Report

Benjamin Feiner,* New York, N. Y., and Jac Siegel,** New Orleans, La.

SUMMARY—This paper gives results of a survey conducted to determine the concentration and nature of dust suspended in the air of New York City. Dust counts were made by the standard light-field impinger technique and by means of the Owens' Jet Dust Counter employing a dark-field oil-immersion optical system.

Results of the dust counts made, together with particle-size studies, and gravimetric analyses are presented.

Introduction

NATURAL DUST consists essentially of meteoric, volcanic, mineral, and organic dusts. City air contains, in addition to this natural dust, particles of suspended matter emitted from a variety of sources. Included in this type of dust are such materials as steel, stone, particles from the combustion of fuel, street sweepings, asphalt particles, and shreds of rubber from tires.

Although the dust suspended in outdoor air is for the most part microscopic in size and therefore not visible, some of its deleterious effects can be readily observed. From the economic aspect these include damage and defacement of buildings, and soiling of curtains and other household furnishings. Less obvious, but none the less real, is the effect of dust in decreasing the amount of ultra violet radiation reaching the earth from the sun.

With the exception of the small percentage of the population who are allergic to household dust, it has not been definitely established that inhalation of the relatively low dust concentrations that obtain in the atmosphere are injurious to health. However, it is believed by many that this dust is a factor in the spread of respiratory disease.

The aim of this survey was to measure the average concentration of dust in New York City air, and to determine the particle size distribution of this dust. Since atmospheric dust concentrations at any one point and time are influenced by many variables, no attempt is made in this report to give detailed counts for the various locations sampled in New York City throughout the year 1936. It is felt that the composite picture presented here is of more value.

Methods of Obtaining Samples

The modified Greenburg-Smith impinger (1)[1] and the Owens jet dust counter (2) were the sampling instruments used. All samples taken with the impinger were collected continuously for periods of one hour or longer at a rate of one cubic foot of air per minute. The impinger samples were counted under the microscope by means of a low-power light field optical system (100X), a calibrated Whipple disc, and a Sedgwick-Rafter counting cell.

The Owens jet dust counter was used where a large number of snap samples were desired. These samples were counted using a dark-field oil immersion optical system (1000X).

†The fourth of a series of four abridged reports of the N.Y.C. Air Pollution Survey conducted by the N.Y.C. Department of Health, Ernest L. Stebbins, Commissioner, under the supervision of Sol Pincus, Deputy Commissioner and Sanitary Engineer.

*At present Industrial Hygiene Engineer, Division of Industrial Hygiene, New York State Department of Labor—formerly (1935-7) Chemist, New York City Air Pollution Survey.

**At present Lieutenant, U.S.N.R., New Orleans, La., formerly (1936-7) Chief Chemist, New York City Air Pollution Survey.

[1]Numerals in parentheses refer to Bibliography.

Results

An average of one to two samples per month were taken in each of the 32 Health Center Districts of New York City. The average dust count of 450 impinger samples was 0.9 million particles per cubic foot of air, with a range from 0.25 to 3.5 millions.

With the Owens jet dust counter, an average of 30 million particles per cubic foot of air was obtained. Ives (3) in his study of 14 American cities obtained an average of 20 million particles for New York City, using the Owens counter with a light-field oil-immersion system.

Particle Size—A study of particle size was made by means of a dark-field oil-immersion system on samples taken with the Owens jet dust counter. The results of these measurements are given in Table 1. It was found that 95 per cent of the particles were less than one micron in size: a median of 0.68 micron was obtained. The size distribution curve is compared in Fig. 1 with that obtained by Ives (3).

Gravimetric Analysis—An analysis of 57 impinger samples combined for gravimetric analysis showed the insoluble solids equal to 0.17 mg per cubic meter of air (0.0048 mg per cubic foot of air). The average count for the dust samples represented in this analysis was 0.3 million particles per cubic foot of air. This is equivalent to 62.5 million particles per milligram for atmospheric dust, when both particle number and weight are determined by impinger.

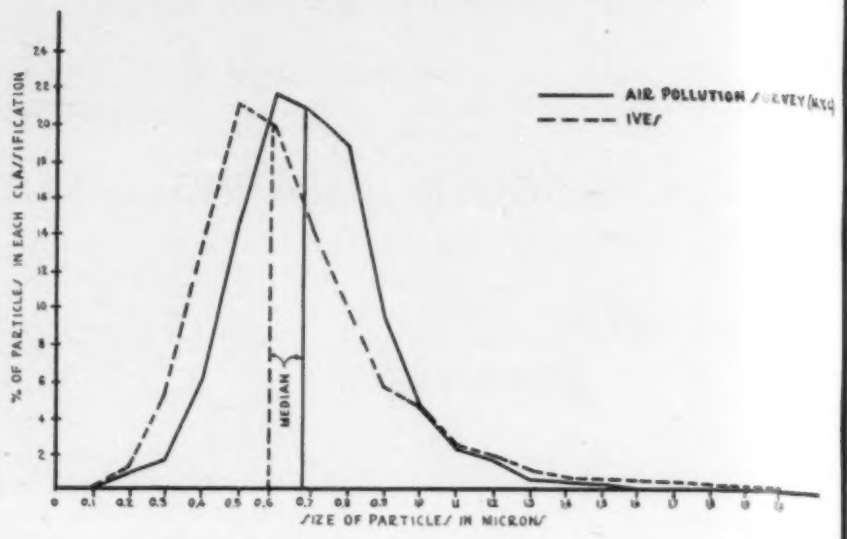


Fig. 1—Size distribution of Owens jet dust particles in New York City air compared with that obtained by Ives in 14 American cities

Conclusion

1. Impinger counts made during 1936 in New York City showed an average dust concentration of 0.9 million particles per cubic foot of air.

2. The average obtained by means of the Owens jet dust counter during this same period was 30 million particles per cubic foot of air using a dark-field-oil-immersion optical system.

3. Ninety-five per cent of the particles obtained on the Owens jet dust strips were less than 1 micron in size, with a median size of 0.68 micron.

4. Gravimetric analysis of a sample representing 57 impinger samples with an average dust count of 0.3 million particles per cubic foot of air showed the insoluble solid content to be 0.17 mg per cubic meter of air.

Acknowledgment — Acknowledgments are made to Messrs. L. C. Newman and N. Williams for the analyses and dust counts reported in this paper. Thanks are due to Dr. Leonard M. Greenburg, Executive Director of the Industrial Hygiene Division of the New York State Department of Labor, and his staff for their aid in this survey.

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Table 1—Size Distribution of Dust Particles in New York City Air as Sampled by the Owens Jet Dust Counter
(100 particles measured on each of 16 slides)

Size in Microns	Slide 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total Count	Pct. in Each Size Group	Ives Pct. Class
0.1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	0	0.00	0.60
0.2	3	8	..	..	..	..	1	1	..	..	..	..	1	..	..	..	14	0.88	0.85
0.3	9	9	..	..	..	1	..	..	..	1	..	1	..	..	1	2	24	1.5	5.1
0.4	16	15	5	1	..	2	3	2	..	3	7	6	9	1	11	10	91	5.7	13.1
0.5	27	18	13	12	3	3	3	6	6	8	20	14	24	15	29	29	230	14.4	20.4
0.6	19	13	12	21	10	8	16	16	19	23	31	34	27	23	28	34	334	20.8	19.2
0.7	11	12	21	19	21	14	31	30	19	25	19	20	20	20	36	15	323	20.1	13.9
0.8	8	7	26	17	25	25	27	25	37	23	18	14	9	24	3	2	290	18.1	9.5
0.9	1	4	12	11	16	27	11	12	13	7	2	7	6	12	1	4	146	9.2	5.5
1.0	3	6	6	5	10	8	2	2	6	7	2	4	1	5	1	2	70	4.4	4.5
1.1	2	3	5	7	6	4	2	2	..	1	..	..	1	..	..	1	34	2.1	2.1
1.2	1	2	..	4	5	6	1	1	..	2	1	..	1	..	..	..	24	1.5	1.8
1.3	..	1	..	1	2	..	1	2	..	..	..	..	..	..	..	..	7	0.44	1.1
1.4	..	1	..	1	..	1	..	1	..	..	..	..	1	..	..	1	6	0.38	0.72
1.5	..	1	..	..	2	..	1	..	..	..	..	..	..	..	..	..	4	0.25	0.54
1.6	..	1	..	..	..	1	..	..	..	..	..	..	..	..	..	..	2	0.12	0.32
1.7	..	..	..	..	..	..	1	..	..	..	..	..	..	..	..	..	1	0.06	0.28
1.8	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	....	0.20
1.9	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	....	0.20
2.0	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	....	0.34
										Total							1600		

Relation of the Ventilation Engineer to Industrial Hygiene

By Herbert G. Dyktor,* Cleveland, Ohio

THOSE WHO are engaged in the governmental practice of industrial hygiene have a large area of interest in common with those who design and install ventilation systems. This is so because the use of local exhaust or process ventilation is one of the favored means of controlling atmospheric contamination in industry. Industrial hygiene engineers often recommend such controls to managements and they turn to the ventilation engineers for their provision. The arrangement seems simple and in theory there should be no cause for any misgiving. However, either because the industrial hygiene engineer does not fully grasp the technical and economic difficulties facing the ventilation engineer, or because the latter does not fully understand what his design is supposed to accomplish to meet the necessary requirements, there is occasional dissatisfaction. It is highly disagreeable for the official industrial hygienist to have to tell management that the new installation still fails to reduce the contamination to the acceptable level. It confounds management and embarrasses the ventilation engineer. This situation, happily infrequent, can be avoided if both engineers meet beforehand in consultation and discuss the problem fully.

Many ventilation engineers have heard of industrial hygiene, some have studied it, but others are still uninformed about this subject. It may be well, therefore, to discuss very briefly the meaning of industrial hygiene and its part in the industrial world.

Governmental industrial hygiene is a definite part of public health work and is a phase like the control of tuberculosis, communicable diseases, sanitation, etc. It concerns itself with the promotion and preservation of good health among industrial workers. It combines the control of the environment to the end that it will not affect the worker, with supervision of the worker himself so that he will not become ill as a result of his occupation.

The official practice of industrial hygiene comprises two spheres of activity. One is related to the individual and is the responsibility of the physician, and the other concerns itself with the individual's working environment and is the responsibility of the engineer. These two spheres are necessarily interdependent and cannot be dissociated any more than cause and effect.

The industrial physician's responsibility is discharged through the plant's medical department. The accepted policy is to examine all workers prior to their employment so that they may be properly assigned to jobs for which they are physically best suited. Care is also taken to ascertain their condition to insure that they will not become a hazard either to themselves or to their fellow workers. Many other activities beyond the scope of this paper are carried on in such departments. However, one of them is to observe carefully those who are exposed to health hazards and, through diagnostic means available to the competent physician, to discover promptly any incipient occupational disease.

It is a well known fact that environment does have an effect on an individual's health and this effect is intensified when the environment contains one of the many hundreds of toxic materials used in industry. It would, therefore, be very unwise to permit a man who had passed successfully through the medical department to enter an uncontrolled work place and expose him to a hazard to his health. As a rule the responsibility for the occupational environment is vested in the safety supervisor, who discharges it to the best of his ability, depending on his knowledge of, and experience with, toxic materials.

In a plant, the hazards to the health and well being of the workers may be roughly divided into two groups. One comprises the factors that are fairly common to all plants, and the other the toxic or obnoxious materials peculiar to the industry.

The common factors in a plant are important because they are basic and can produce serious consequences if they are neglected. Foremost among these factors are housekeeping and sanitation. If the requirements concerning each of these are not properly met, there is no foundation upon which good medical and safety programs can be built. Housekeeping is a particularly important item to the ventilation engineers because if it is poor, especially in dusty operations, it will superimpose an excessive load on the process ventilation they may design and furnish.

Other factors are lighting, noise, radiant energy, fatigue, etc. General ventilation may come under this heading, but it is usually natural and is intended to remove body odors, moisture and heat. Some air movement is also physiologically necessary and occasionally mechanical means are used to provide it where natural means prove inadequate.

The toxic materials in the form of dust, vapor, mist or gas gain entrance to the body mainly through inhalation. Contact with some of these will produce dermatoses, a discussion of which is not pertinent at this time. Since inhalation is the chief portal of entry, the protective measures must be obviously so arranged that they will prevent the contaminant from reaching the worker's face.

The most prevalent industrial health hazard is dust of inorganic

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origin. However, not all dusts are equally toxic and some are merely of the nuisance variety. On the other hand, dust of the siliceous type may, if certain conditions are met, produce a lung disease. In this case, the determining factors are percentage of free silica, particle size of the dust, concentration in the air, length of exposure to it, and the susceptibility of the worker. There are also other inorganic, organic, and metallic dusts which have a varying harmful effect on man's health, if uncontrolled.

Certain metal fumes, solvent vapors and a variety of gases, also affect the human body. Depending on the degree of toxicity and existing concentration, these will, when inhaled, be conveyed by the blood to such organs as the liver, kidneys, etc., where they will carry out their destructive work. Some will even affect directly the blood cells or the central nervous system.

Control methods for these hazardous materials can be divided into a few groups such as substitution of a non-toxic (or less toxic) material for the more toxic one, isolation or enclosure of the process, wet methods in dusty operations, local exhaust ventilation, and personal protection, which includes all types of respirators or masks.

Frequently it is impossible to make a substitution or enclose the process because of manufacturing difficulties. Use of water is much too limited and workers object strenuously to the wearing of any face piece which impedes their breathing. Therefore, local exhaust ventilation is frequently selected and provides a very effective control method, if properly designed and located. As already stated this is the area of interest common to both industrial hygiene and ventilation engineers. It is in this area that there should be some mutual understanding with great benefit to both and to the ultimate consumer: the industrial worker. The official industrial hygiene engineer recommends the air control method, the ventilation engineer designs it, the plant buys it, but it is the worker who reaps the benefit of working in a hygienic atmosphere. Of course, we all benefit by it because all of us are an integral part of the world we live in, and if a part of it such as is represented by the workers, fails because of preventable illness, then the rest of us will thereby suffer, too, in one way or another.

The thought may now arise as to how the official industrial hygienist, whether he be an engineer, physician, or chemist, appears in the picture. He is primarily a consultant, an educator, but he is also called in at the request of management, labor, or the plant physician or nurse. Many investigations are also made as part of a planned program of action or upon complaint from individual workers. The plant is surveyed from the hygienic point of view and evaluation is made of how the mentioned physical factors and toxic materials are handled so that they will not become a hazard to the workers' health. On the basis of the observations and findings, the competent industrial hygienist is then in a position to make such recommendations as his education, training, experience, and understanding of the situation, will indicate as necessary to eliminate the hazard or control it satisfactorily. Consequently when the official industrial hygiene engineer recommends local exhaust ventilation, he wants the atmospheric contaminant to be captured at the point of origin or as close to it as possible, and before it reaches the worker's face or disperses into the general workroom atmosphere. To provide successfully such exhaust ventilation, the ventilation engineer must understand not only the process but have an appreciation of some of the pertinent characteristics of the toxic contaminant. He should know its physical properties and degree of toxicity as this will enable him to complete a successful job. In this case, success is evidenced by the reduction of air contamination around the worker to an acceptable level. The industrial hygiene engineer determines this level by various tests and he is well armed with the necessary data. Medical and engineering research studies together with the experience accumulated over a long period of years, have evolved an imposing list of permissible concentrations for many contaminants, and this work still continues.

When a ventilation system has been installed, the only criterion used in judging its effectiveness, is the remaining concentration of the contaminant in the air breathed by the worker. This is the only yardstick that can be applied by the industrial hygiene engineer and to him the design, construction, and efficiency of the system are of subordinate importance. Years of observation have disclosed installations which violated most of the rules of good engineering practice and yet, have performed excellently from the health point of view. On the other hand, technically perfect installations have been observed which did not attain the same degree of success.

Basic objectives which induce industrial management to purchase a ventilation system are: (1) to remove undesirable or unwanted air, whether it be a toxic dust, vapor, or gas, or just plain heat, (2) to provide an atmosphere which will not affect the worker's health and thus will not impair his productive efficiency, and (3) to protect costly equipment from the abrading or corrosive action of some contaminants. Regardless of the reason or combination of reasons, and whether or not it has been recommended by an official representative, when the ventilation system is ordered it is then the time the ventilation engineer must gather all available information.

Since the system must eliminate the contaminant to be fully effective, the design and location of the hood or hoods assume prime importance, and it is in this respect that the greatest number of shortcomings have been observed. A hood must be of sufficient size and shape to capture all of the contaminant at the source or as near to it as practicable. Since air from all directions will enter a hood under negative pressure, and since the air in back of it is not as contaminated as that in front of it, flanges around the edge of the hood will, in many instances, provide the necessary directional control. However, very few

flanged hoods are used in practice. For reasons previously explained, it is very much preferred to remove toxic materials by downdraft or lateral draft rather than by updraft through a canopy type of hood. Although the latter has its use in a few instances only, it is generally furnished regardless of the nature of the contaminant.

The effectiveness of a hood can be substantially increased by the provisions of partitions or baffles which localize and intensify the action of the exhaust system. They will also provide protection against interfering drafts caused by the opening of windows and doors in the summer, by the use of suspended unit heaters in the winter, and by the movement of men and materials all year 'round. In many instances, where such protection is impossible, higher velocities at face of hood are necessary to overcome this interference with air flow. In any event, this face velocity is just as important as the transport velocity in the ducts, and in fact is more important when handling vapors and gases.

Another often observed deficiency is the lack of provision for make-up air. This deficiency manifests itself in the winter when the opening of a door to a workroom becomes a strenuous operation. In some isolated cases, not to mention reduced efficiency of the system because of air restriction, there has been much breakage of window panes because of this lack of air supply.

A further point to be remembered is that an installation must be so designed that internal parts of it may be conveniently cleaned without involving a major dismantling job. A large number of cleanouts will also help in this respect.

Power plant capacity must be adequate for the intended purpose and lack of it cannot be condoned because it may be the cause of condemnation of the equipment. Such incidents cause much embarrassment to industrial hygienists, as they are greatly in favor of adequate exhaust ventilation for processes creating air contamination.

Serious attention must be paid also to the condition of the return air system using the recirculation principle, for the purpose of conserving heat in winter time. Because of inadequate or improper filtering in such systems, some contamination will constantly be returned to the general workroom air. The concentration of the contaminant in the returned air may be minute but its effect will be cumulative and toward the end of the day may assume a value dangerous to the workers' health.

The discharge end of the ventilation system is sometimes located carelessly, in the belief that the discharge velocity will propel the air contaminated with vapors or gases sufficiently far away from the building to obtain mass dilution. In many instances, and because of poor location and shortness of pipe, a change in the wind direction will cause the contamination to be blown right back into the workroom through an adjacent open window or door. The end result causes much disappointment and provides no relief to the situation.

There are many other observations that could be made but these will suffice for the moment. It is hoped that enough material has been brought forward to make the ventilation engineer realize that when he is called upon to design a system, his responsibility does not end there. He must know that the ventilation system has for its purpose to remove the undesirable or contaminated air and in such a manner that it will not remain a hazard to the worker's health. Furthermore, the engineer must preclude the possibility of creating a hazard to the neighboring worker or to the neighborhood in general.

It should be understood, of course, that mere criticism is not the basis for making the foregoing observations, but that it is rather a sincere desire to obtain more satisfactory results in the field of industrial ventilation. In most instances, trouble encountered is the result of a case of omission rather than of commission.

During the war the importance of industrial hygiene activities was acknowledged because of the necessity of producing large quantities of material and, to attain this goal, available labor had to be kept on the job at its highest level of production without regard to costs. The fact that the war has ended will not minimize this importance or permit relaxation of the hygienic controls. In fact, enlightened management will desire more thoroughgoing controls of this type because it realizes that only through high efficiency in production, which means not only improved technical processes but efficient and healthy workers, can it meet the keen competition that free enterprise connotes.

Finally, to achieve success in this endeavor it may be well for the professions concerned in the matter of air sanitation, to develop a much closer cooperative relationship than has been done heretofore.

MOSES APPOINTED REGIONAL REPRESENTATIVE

Walter B. Moses, a member of the ASHVE, has been appointed Regional Representative for Marlo Coil Co., Kansas City, Mo., in Louisiana, Mississippi, Alabama, and Northwestern Florida, according to an announcement made by the company. Mr. Moses, a graduate engineer, is well known in the refrigeration and air conditioning fields. He is resuming his commercial and engineering activities after wartime service as Assistant Naval Architect of Pendleton Shipyards Co., Inc., New Orleans. His headquarters will be at 7836 St. Charles St., New Orleans, La.

CAPT. AKERS RELEASED BY NAVY

Word has been received that Capt. George W. Akers, USNR, has been released by the Navy to inactive duty and has rejoined the George W. Akers Co., as Manager. He has been on active duty since February 7, 1941, serving for 32 months in both the Atlantic and Pacific, on board the U.S.S. Markab, a destroyer tender. He served originally as Chief Engineer and for the last two years as Repair Officer. Later he was Shop Superintendent at Charleston Navy Yard, and following that was in command of Naval Training Schools, Detroit, Mich.

The Transmission of Solar Radiation Through Flat Glass Under Summer Conditions

By George V. Parmelee,* Cleveland

This paper is the result of research carried on by the American Society of Heating and Ventilating Engineers at its Research Laboratory located at Cleveland, Ohio.

SUMMARY—This paper is a mathematical analysis of the transmission and absorption characteristics of unshaded, unfigured, smooth, flat glass for direct radiation from the sun and scattered radiation from the sky. The results are presented in the form of curves for single and double glass of all degrees of transmissivity and include the highly transparent types such as ordinary window glass, as well as those types, such as the so-called heat absorbing glasses, which are strongly absorbent in the infra-red.

In addition, charts are presented showing the rate of heat transfer, to the interior from the surface of the glass, as it is influenced by the indoor and outdoor temperatures and by the amount of solar energy absorbed by the glass. The transmission characteristics of some typical window glasses are given together with data on the intensity of the direct solar and sky radiations. A sample problem illustrates the use of the information given in this paper.

INTRODUCTION†

During the latter half of 1944, G. V. Parmelee, the author of this paper, prepared at the ASHVE Research Laboratory, Cleveland, Ohio, a comprehensive report on the subject of heat transmission through glass. This was prepared under the guidance of the Technical Advisory Committee on Glass.†† Mr. Parmelee reviewed critically most of the published information on heat transfer through glass as well as a great number of unpublished reports made available to the Laboratory from various sources. This report, now under review by an editorial committee, will be published later as a special ASHVE research bulletin.

In that portion of the report dealing with solar radiation, it is pointed out that the information which is generally available at the present time on the transmission of solar heat through glass and the effect of temperature difference between inside and outside is incomplete, especially with regard to the effects of shading devices, of double windows, and of the use of heat absorbing glass. Some of the test data reviewed were shown to be inconsistent because of time lag and other factors inherent in the test apparatus. It was also suggested that the extrapolation of some of the test data from test conditions to design conditions was open to criticism on several grounds, not the least of which was the fact that the design conditions assumed, based on observations made in Pittsburgh, Pa., were by no means representative of other localities.

The Glass Committee, after reviewing the report, recommended that the Research Laboratory undertake, as soon as possible, more exhaustive studies on solar radiation transmission through glass than had previously been made under its direction. In particular the Committee recommended that tests be made with greater precision, in order to separate more adequately the transmission characteristics of the glass itself from such absorption characteristics of the apparatus as might involve either a serious time lag or heat storage effects. It was suggested that particular care be taken to reduce to a minimum the necessity for making corrections for heat flow through parts of the apparatus other than the glass areas under investigation.

Because of the great importance of securing accurate data on solar radiation transmission through glass areas in connection with calculations of cooling loads (and sometimes of heating loads), this research program was initiated early in 1945. Parallel with the construction of the test apparatus, it seemed advisable to analyze the problem thoroughly from the standpoint of physical characteristics of glass and the known methods of heat flow by radiation, conduction, and convection, so that if it were found, as the actual test work proceeded, that close agreement could be obtained between predicted and determined rates of heat flow, a considerable amount of test work could probably be eliminated. This present report, setting out the methods used in the analysis and summarizing the results obtained, is submitted to the membership of the Society for criticism and comment. It should be considered as a progress report on this phase of the Society's research work.

Details of the derivation of the principal equations used in the various phases of the problem have been separated from the text and given in Appendices. It is hoped that in doing so the main features of the study will be made more readily available to the membership and to other interested readers. The laboratory will be glad to receive comments and criticisms which should be addressed to ASHVE Research Laboratory, 10700 Euclid Ave., Cleveland 6, Ohio.

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*Research Fellow, ASHVE Research Laboratory, Member ASHVE.

†Introduction by Cyril Tasker, Director of Research, ASHVE.

††R. A. Miller, Pittsburgh, *Chairman*; L. T. Avery, Cleveland; H. C. Dickinson, Washington; J. E. Frazier, Washington, Pa., E. H. Hobbie, New York; J. C. Hostetter, St. Louis; L. K. Jones, Pittsburgh; J. H. Lewis, Kingsport, Tenn.; F. L. Martin, Philadelphia; W. C. Randall, Detroit; V. Sanders, Pittsburgh; L. E. Seeley, Durham, N. H.; H. B. Vincent and G. B. Watkins, Toledo; and F. C. Weinert, Detroit.

Purpose and Scope of Report

THE PURPOSE of this report is to present the results of an analysis of heat flow through glass windows exposed to solar radiation. Details of the methods by which they were obtained are given in three Appendices. As no new data are presented, confirmation by actual tests will be lacking until experimental work now in progress is completed. Most of the fundamental data required for the analysis were, however, found in the literature and only required organization in a form suitable for use by the air conditioning engineer. Although part of the data given in this paper applies only to summer conditions, it is planned to extend the analysis in a future report to cover winter conditions.

Only u n s h a d e d, unfigured, smooth, flat glass has been considered at this time. At present there is a lack of exact data on the absorption and reflection characteristics of the various types and colors of surfaces such as found in shades, particularly in regard to the variation of these characteristics with respect to the angle of incidence of the sun. It, therefore, did not appear practicable to attempt to evaluate shading effects mathematically.

Considerable impetus was given this preliminary analysis by the interest shown by, and the suggestions received from, the technical departments of several glass manufacturers and by the published work of Hottel and Woertz[1] on the characteristics of flat plate solar heat collectors, from which some valuable references were secured.

Physical and Chemical Properties of Glass

The important properties of glass to be considered are the index of refraction and the absorptivity of the glass for radiation from sources at different temperatures. Of secondary importance are specific heat, specific weight, and thermal conductivity. The first two characteristics are a function of the wavelength of the incident radiation. One wavelength range to be considered lies between 0.29 μ (microns) and about 2.5 μ and includes the solar and sky spectra. In this band lie the ultraviolet, the visible, and the infra-red radiations. The second range consists only of the invisible longer wavelength infra-red radiation between about 4 μ and 100 μ. This range is characteristic of radiating bodies having temperatures in the neighborhood of 0 to 100 F. Ordinary glass transmits the shorter wavelengths with relative ease, whereas it is entirely opaque to the longer wavelength range. Only the effect of the former need be considered, therefore, with respect to absorption and index of refraction. It will be shown in a later section that for all practical purposes both of these properties can be considered to remain constant throughout the wavelength range of the solar spectrum.

The index of refraction is a measure of the degree to which a radiant ray is bent toward the perpendicular to the surface of a substance of high density, through which it is to pass, from a substance of lesser density such as air. A sodium light ray is often used in determining this property. Reflection of radiant waves from either surface of the substance is closely related to this property. The index of refraction μ is defined as the ratio of the sine of the angle of incidence, i, to the sine of the angle of the refracted ray i' or

$$\text{index of refraction, } \mu = \frac{\sin i}{\sin i'} \quad \ldots (1)$$

These angles are measured from the normal to the surface as shown by Fig. 8 in Appendix I. The ray after emerging from the lower surface is bent back parallel to its entering path, but, of course, is displaced. An index of 1.526 was used in all calculated data given in this paper (see Appendix III).

The absorption characteristics of glass are dependent upon the chemical constituents. Ferric and ferrous oxides are two compounds used to increase the absorption of glass for solar radiation. The former is strongly absorbent in the ultra-violet portion of the spectrum, the latter in the infra-red portion, and various degrees of absorption are obtained by controlling the quantities of these two compounds. The thickness of the glass sheet is also a factor in reducing the energy of the incident ray. Since the energy in the solar spectrum at earth level is divided among ultra-violet, visible, and infra-red radiation about as 3, 44, and 53 per cent, respectively, theoretically about 56 per cent of the total energy could be excluded by a heat absorbing glass without impairing the light transmitting qualities.

Specific heat and density of the glass are related to the storage effect. In ordinary glass installations this effect is unimportant and a later section deals with calculations showing the magnitude of heat storage.

Specific thermal conductivity of glass is not of great importance in conduction heat transfer because, although the value is low compared to metals, it is high compared to the conductance of air films on either side of the glass sheet. Also, the sheets of glass in normal usage are thin compared to the thickness of other building materials, which have much lower conductivities.

To simplify the analysis of the problem, the effects of solar radiation and of temperature difference were considered separately. Direct radiation and sky radiation, the two components of solar radiation, were also treated separately. Direct radiation refers to the radiant energy in the beam or ray from the sun itself. Sky radiation refers to the short-wave radiation of the sun that has been scattered by the atmosphere and comes to the earth from all directions. It does not include the low temperature long-wave radiation from the atmospheric water vapor.

The fractions of the direct and sky radiations transmitted by glass were calculated first from its known physical properties. Then, using the same data, calculations were made of the fractions of the radiation absorbed and reflected by

[1]Numerals refer to Bibliography.

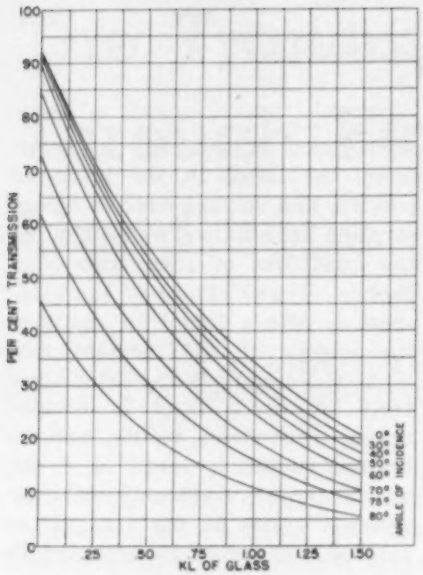

Fig. 1—Transmission of direct solar radiation by a single sheet of glass

glass. The methods used are described in detail in Appendix I. Finally, a heat balance was set up between the absorbed solar energy and the heat transfer from the outdoor surroundings to the glass on one hand, and the heat transfer from the glass to the indoor surroundings on the other hand. From this heat balance, the net flow to the interior could be computed.

Low temperature radiation and natural convection effects on the indoor side were computed separately as outlined in Appendix II. Low temperature radiation and the effect of wind on the weather side were combined in a single coefficient because of the lack of specific data on each of these points. This is discussed in greater detail in Appendix III.

The Transmission, Absorption, and Reflection of Direct Solar Radiation

The following formulae, which express the transmitted, absorbed, and reflected energy as fractions of the incident energy, were developed by methods outlined in Appendix I. T_1, A_1, and R_1 represent these fractions, respectively. For single sheets of glass

$$T_1 = \frac{(1-r)^2 g}{1-r^2 g^2} \quad \ldots\ldots\ldots\ldots\ldots (2)$$

$$A_1 = 1 - r - \frac{(1-r)^2 g}{1-rg} \quad \ldots\ldots (3)$$

$$R_1 = r + \frac{rg^2(1-r)^2}{1-r^2 g^2} \quad \ldots\ldots\ldots (4)$$

Evaluation of the right hand member of each equation required two separate computations, one for each value of r, according to Fresnel's laws of reflection. T_1, A_1, and R_1 are found by averaging these two results arithmetically. The g term expresses the depletion of the radiant energy by absorption. Both r and g are functions of the angle of incidence and are completely treated in Appendix I.

Figs. 1 and 2 show the transmission and the absorption expressed in percentages as functions of both the angle of incidence of the solar ray and the absorption characteristic, KL, of the glass. The latter is

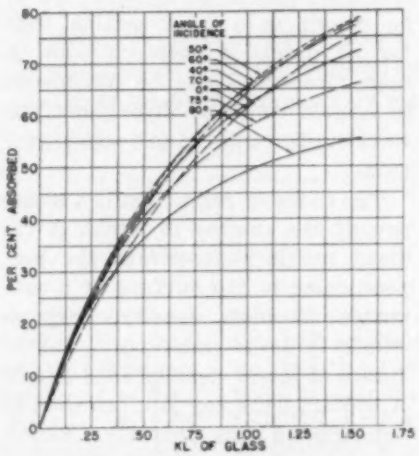

Fig. 2—Absorption of direct solar radiation by a single sheet of glass

the product of the extinction or absorption coefficient, K, and the thickness of the glass, L. The term is dimensionless, since K is expressed as absorption per inch and L is in inches. (The reader should not confuse K with thermal conductivity, k, which has dimensions Btu per (hr) (sq ft) (deg F per inch). For example, the direct solar energy transmitted per unit area of the glass is the direct solar energy measured normal to the sun's rays (see Fig. 14 of Appendix III) times the cosine of the angle of incidence times the appropriate transmission percentage expressed as a fraction.

Two sheets of glass will now be considered. The subscript 1 refers to the fractions transmitted, absorbed, or reflected by the outdoor sheet as if it were a single sheet. In like manner the subscript 2 refers to the indoor sheet. The double subscript 1, 2 refers to the combination. The formulae which follow are completely developed in Appendix I.

$$T_{1,2} = \frac{T_1 T_2}{1-R_1R_2} \quad \ldots\ldots\ldots (5)$$

$$A_1 \text{ of}_2 = [1 - R_2\ (R_1 - T_1)] \times \left[\frac{1-(R_1+T_1)}{1-R_1R_2}\right] \ldots (6)$$

$$A_2 \text{ of}_1 = [T_1]\left[\frac{1-(T_2+R_2)}{1-R_1R_2}\right] \quad \ldots\ldots\ldots (7)$$

$$R_{1,2} = R_1 + \frac{T_1^2 R_2}{1-R_1R_2} \quad \ldots\ldots (8)$$

The fraction absorbed by each sheet is given, rather than the total absorption, because the computations require that each be known. The total fraction of the incident radiation that is absorbed is simply the sum of equations (6) and (7). Fig. 3 shows the transmission of double glass expressed as a function of the angle of incidence and the sum of the KL characteristics of each of the two sheets. The order in which the sheets are placed, if they be of different characteristics, has no bearing on either the fraction transmitted or the fraction absorbed *by the combination*. However, the fraction absorbed by each sheet *and, therefore, the rate*

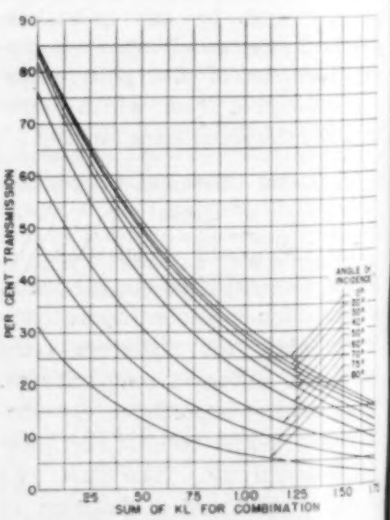

Fig. 3—Transmission of direct solar radiation by two sheets of glass vs. the sum of the KL for each sheet

Table 1—**Fractions of Sky Radiation Transmitted (T), Absorbed (A_1 and A_2), and Reflected (R) by Single and Double Glass (Index of Refraction = 1.526)**

	T	A_1	A_2	R
Single glass (KL = 0.054)	0.778	0.060	....	0.162
Single glass (KL = 0.419)	0.510	0.365	....	0.125
Double glass (both sheets KL = 0.054)	0.631	0.067	0.048	0.254
Double glass (inside KL = 0.054) (outside KL = 0.419)	0.411	0.393	0.032	0.164
Double glass (both sheets KL = 0.419)	0.269	0.387	0.190	0.154

of heat transfer from the inner sheet, depends upon the order. Fig. 4 gives these fractions for one particular case, that in which the inner glass has a KL of 0.054 (closely equal to that of grade A double strength glass). The outer glass may have any characteristic.

The Transmission, Absorption, and Reflection of Sky Radiation

Although the intensity of the short wave radiation from the sky is relatively low as compared to the direct intensity of the sun, its effect on heat gains in total may be considerable. For example, buildings are often arranged with large window areas exposed to the northern sky. The heat flow in such cases may amount to a sizable fraction of the total cooling load.

Because the sky radiation comes from all angles, it was necessary to compute the fractions transmitted, absorbed, and reflected by methods of graphical integration outlined in Appendix I. In effect the radiation can be considered as coming from an angle of about 60 deg measured from the perpendicular to the glass. The results for certain types and combinations of glass are given in Table 1.

Heat Flow Due to Absorbed Heat and Temperature Difference

Fig. 5, the calculations for which are explained in detail in Appendices II and III, shows the rate of heat flow from a single sheet of glass to the interior (or the outside, depending upon the temperature). This heat flow depends upon three factors—the difference between inside and outside air temperatures, the fractions of the direct and sky radiations absorbed, and the outside film coefficient. Fig. 3 and Table 1 are used to estimate the solar heat absorbed. It also depends to some extent upon the mean temperature, since this affects the unit rate of low temperature radiation from the glass to the indoor surroundings. Four curves are drawn for several outdoor temperatures and an outdoor film coefficient, h_o, of 4.0. Both convection and low temperature radiation are combined in the coefficient, because there is at present insufficient experimental data to consider each separately. Further, it is assumed that the indoor surroundings seen by the glass are at the same temperature as the indoor air. The data given in Fig. 5 would not apply to a structure, for example, a greenhouse, in which most of the surface is glass and would therefore be at the same temperature. Heat gains or losses by radiation obviously cannot take place between surfaces at the same temperature.

Although the curves are not exactly straight lines, they were so drawn. They are seen to diverge to some extent, indicating that the fraction of the absorbed solar heat transmitted to the interior is not constant. The divergence is also due to changes in heat transfer coefficients because of temperature changes. For zero heat absorption, the overall transmission coefficient can be estimated, and in spite of some variations, is substantially equal to 1.0 Btu per (hr) (sq ft) (deg F) for the conditions assumed.

The curves, although drawn for an 80 F indoor temperature, are applicable to any indoor temperature within 5 to 10 deg of 80 F. For example, if the indoor temperature were 70 F and the outdoor 85 F, the temperature difference would be 15 deg and the curve for 95 F outside, 80 F inside, could be used. Two curves for $h_o = 8.0$ are shown to illustrate the effect of increasing the convection on the outer surface of the glass.

Fig. 6 gives data applicable to double glass. Here it is necessary to know the amount of heat absorbed by each sheet of glass. Fig. 4 and Table 1 have been produced for that purpose.

Method of Calculating Heat Gains Due to Solar Radiation on Glass

The curves presented in this report together with other data given in the Appendices permit the calculation of heat gains due to solar radiation on unshaded windows. Their use is best illustrated by examples. Let it be assumed that the indoor temperature to be maintained is 80 F, that the outdoor temperature is 95 F, that the sun time is 2 P.M., and that the date is July 1. The window, which lies flush with the surface of a western wall, is single and has a KL of 0.054. The latitude is 40 deg north. It will be assumed

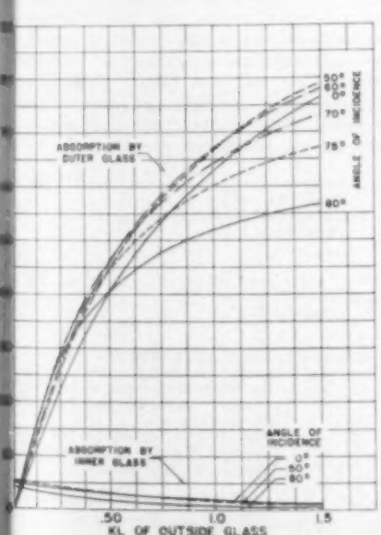

Fig. 4—**Absorption of direct solar radiation by two sheets of glass when the KL of the inner sheet equals 0.054**

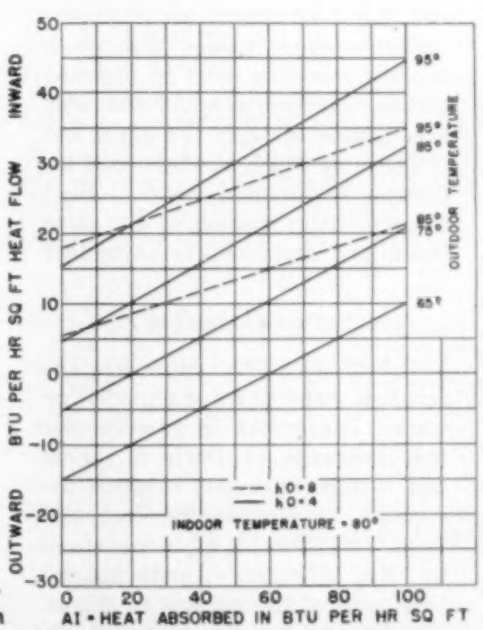

Fig. 5—**Heat flow at the indoor surface of a single sheet of glass**

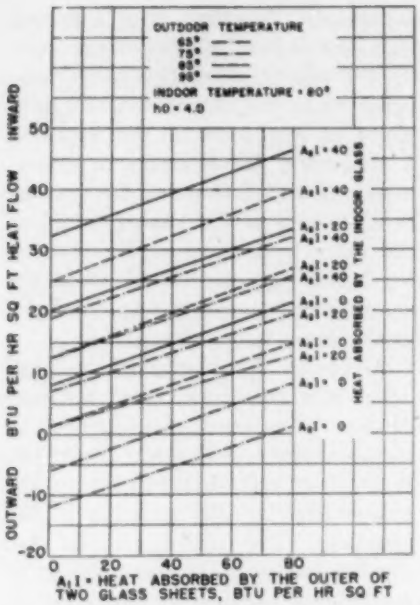
OUTDOOR TEMPERATURE
65°
75°
85°
95°
INDOOR TEMPERATURE = 80°
h0 = 4.0
OUTWARD BTU PER HR SQ FT HEAT FLOW INWARD
HEAT ABSORBED BY THE INDOOR GLASS
A1 = HEAT ABSORBED BY THE OUTER OF TWO GLASS SHEETS, BTU PER HR SQ FT

Fig. 6—Heat flow at the indoor surface of the inner of two sheets of glass

that curve A of Fig. 14 (Appendix III) is applicable.

Solution:

From Fig. 16 (Appendix III) the altitude is 62 deg; the angle between the sun and the surface is 26 deg. Hence the angle of incidence is 90—26 or 64 deg.

From Fig. 14 (Appendix III) the direct normal solar radiation is 283 Btu per (hr) (sq ft). The radiation on the window is 283 x cos 64 deg or 124 Btu per (hr) (sq ft).

Fig. 15 (Appendix III) Curve A (recommended in the absence of more complete data) shows that the direct solar radiation at 62 deg altitude is 5.3 times the sky radiation. Therefore, the sky radiation on a horizontal plane is 283 ÷ 5.3 or 53 Btu. Half of this or 26.5 falls on a vertical plane.

From Fig. 1, 73 per cent of the direct energy, or 90.5 Btu per (hr) (sq ft) is transmitted. From Table 1, 77.8 per cent of the sky radiation, or 20.5 Btu, is transmitted; 6 per cent, or about 1.5 Btu, is absorbed.

From Fig. 2, 6 per cent of the direct radiation, or about 7.5 Btu, is absorbed, making a total of 9 Btu per (hr) (sq ft) absorbed.

In Fig. 5 the curves for $h_o = 4.0$ are recommended for summer use. For a 95 F outdoor temperature, an 80 F indoor temperature, and 9 Btu solar heat absorbed, the heat flow inward is 18 Btu. The total heat flow is summarized as follows:

Direct solar radiation transmitted	90.5
Sky radiation transmitted	20.5
Heat flow due to absorption and temperature difference	18.0
Total, Btu per (hr) (sq ft)	129.0

If a heat absorbing glass were added on the weather side of the plain glass, the heat transmission would be revised as follows:

From Fig. 3 for a *KL* sum of 0.473, the percentage transmitted is 37 per cent, or 46 Btu. Fig. 4 shows that the outer glass absorbs 41 per cent or 51 Btu; the inner glass absorbs 2.5 per cent or about 3 Btu. Table 1 shows that 41.1 per cent of the sky radiation is transmitted, or about 11 Btu; 39.3 per cent absorbed by the outer glass, or 10.5 Btu; and 3.2 per cent absorbed in the inner, or about 1.0 Btu. The total absorption is 61.5 Btu by the outer sheet and 4 Btu by the inner. The heat flow from Fig. 6 for this combination is thus 20.5 Btu per (hr) (sq ft).

Summarizing:

Direct solar radiation transmitted	46.0
Sky radiation transmitted	11.0
Heat flow due to absorption and temperature difference	20.5
Total, Btu per (hr) (sq ft)	77.5

The calculations shown above are somewhat tedious. However, when a systematic study has been made of the characteristics of typical glasses, it will be possible to express the total heat flow for any particular glass as a function of the radiation intensity, the angle of incidence, and the temperature difference.

It must be clearly understood by the reader that experimental data which wholly substantiate these calculations have not yet been obtained. Further, because of the storage capacity of interior walls and floors on which will fall the sunlight which passes through a window, some lag must be expected between the time at which the solar heat passes through the glass and the time at which the heat load influences the cooling system. Heat storage characteristics of the glass itself are discussed in Appendix III.

Acknowledgment

The data in this paper are the result of many hours of painstaking work. The writer is grateful for the assistance of Doris M. Dietz and George Springer, research assistants, who made the computations. Considerable labor was saved by Mr. Springer's mathematical treatment of the various problems. Thanks are due the technical departments of the Libbey-Owens-Ford Co., Mississippi Glass Co., and Pittsburgh Plate Glass Co. for data which appear in this paper, and the Chairman and members of the Technical Advisory Committee on Glass for helpful criticisms and suggestions. The writer also wishes to thank Cyril Tasker, Director of Research, for his encouragement and criticisms and for his suggestions in regard to the arrangement of the paper which, it is hoped, will stimulate reader interest in research papers.

Appendix I

The Calculation of Transmission, Absorption, and Reflection of Solar Energy by Glass

Single Glass

If one looks out through a window at night from a lighted room one sees two reflected images of objects in the room. Closer examination would reveal others of much diminished intensity. The two images are reflections from the first and second surfaces of the glass; the others are due to successive internal reflections. Stokes[3] in 1862 analyzed mathematically this effect of multiple reflections of light incident upon one or more sheets of a transparent substance. The general method used by Stokes has been followed in this paper but with considerable simplification in the treatment of several sheets of glass separated by air spaces.

Light and heat radiation are considered to be electromagnetic transversely vibrating waves, components of which vibrate in different planes. The reflection of any single component will depend upon the plane in which it is vibrating. This radiant energy will be considered as having components of equal intensity in all planes. Each such component may be broken down into two, one vibrating in a plane perpendicular to the sheet of glass, the other in a plane parallel to the glass. If these two sub-components are summed, the total radiation can then be considered as consisting of two components, one in each plane. Fresnel has expressed the specular reflection of each of these components from a single surface by the following equations:

$$r_{p1} = \frac{\sin^2 (i - i')}{\sin^2 (i + i')} \qquad (9)$$

$$r_{p2} = \frac{\tan^2 (i - i')}{\tan^2 (i + i')} \qquad (10)$$

where i = angle of incidence.
i' = angle of refraction.
r_{p1} = fraction reflected of the component parallel to the plane of incidence.
r_{p2} = fraction reflected of the component perpendicular to the plane of incidence.

At normal incidence, the amount of each component reflected is the same, and if air and glass are the mediums involved, the fraction reflected is expressed by the formula

$$r = \frac{(\mu - 1)^2}{(\mu + 1)^2} \qquad (11)$$

where μ is the index of refraction of the glass. Fig. 7 shows the percentage of each component reflected from a single surface, as well as the average.

Fig. 8 represents the first, second, and several successive internal reflections of a ray striking the surface of a single sheet of glass at the angle of incidence i. The intensity of radiation is designated by I_o. First, let it be assumed that there is no absorption by the glass. The total energy transmitted, I, is given by the sum of the infinite series:

$$I = I_o [(1-r)^2 + r^2 (1-r)^2 + r^4 (1-r)^2 + \ldots\ldots] \ldots\ldots \quad (12)$$

where r is the fraction of each component reflected calculated by Equations (9), (10), or (11). Since the incident energy has been assumed to be equally divided between the two components, the total fraction transmitted, T', neglecting absorption, is, by summation of the series

$$T' = \frac{I}{I_o} = \frac{T'_{pl} + T'_{pd}}{2} \quad \ldots\ldots\ldots\ldots (13)$$

where

$$T'_{pl\ (or\ pd)} = \sum_{pl\ (or\ pd)} (1-r)^2 + r^2 (1-r)^2 + r^4 (1-r)^2 + \ldots\ldots$$

$$T'_{pl\ (or\ pd)} = \frac{1 - r_{pl}}{1 + r_{pl}} \text{ or, } \left[\frac{1 - r_{pd}}{1 + r_{pd}} \right] \quad \ldots\ldots\ldots\ldots\ldots\ldots (14)$$

However, as each ray passes through the glass sheet part of the energy is absorbed. If the sheet of glass be divided into a number of layers of equal thickness, dL, each of which reduces the intensity by dI in proportion to its thickness, dL, and its absorption or extinction coefficient, K, then

$$-dI = IK dL \quad \ldots\ldots\ldots\ldots\ldots\ldots (15)$$

Integrating between limits of I_o and I and zero and L:

$$\frac{I}{I_o} = e^{-KL} = g' \quad \ldots\ldots\ldots\ldots\ldots\ldots (16a)$$

where g' equals the fraction of the energy available after passage through the glass. The thickness of the glass, L, must, of course, be modified to account for the refraction or bending of the ray toward the perpendicular. The KL term is modified, then, by dividing by

$$\sqrt{1 - \frac{(\sin i)^2}{(\mu)^2}}$$

so that the modified fraction available, g, becomes

$$\log_e g = \frac{-KL}{\sqrt{1 - \frac{(\sin i)^2}{(\mu)^2}}} \quad \ldots (16b)$$

The term K, which has units per inch, should not be confused with specific thermal conductivity, k, which has units Btu per (hr) (sq ft) (deg F per inch). The infinite series given by (12) when modified by g becomes

$$I = I_o [g (1-r)^2 + r^2 g^2 (1-r)^2 + r^4 g^4 (1-r)^2 + \ldots\ldots] \ldots (17)$$

The general expression for the transmission of any component, then, becomes, for single glass sheets:

$$T_1 = \frac{(1-r)^2 g}{1 - r^2 g^2} \quad \ldots\ldots\ldots\ldots\ldots\ldots (18)$$

Similarly the expression for reflection is found to be:

$$R_1 = r + \frac{r g^2 (1-r)^2}{1 - r^2 g^2} \quad \ldots\ldots\ldots\ldots\ldots (19)$$

And since the fraction absorbed by the glass, A_1, is found thus:

$$A_1 = 1 - R_1 - T_1 \quad \ldots\ldots\ldots\ldots\ldots\ldots (20)$$

the expression for absorption is:

$$A_1 = 1 - r - \frac{(1-r)^2 g}{1 - rg} \quad \ldots\ldots\ldots\ldots (21)$$

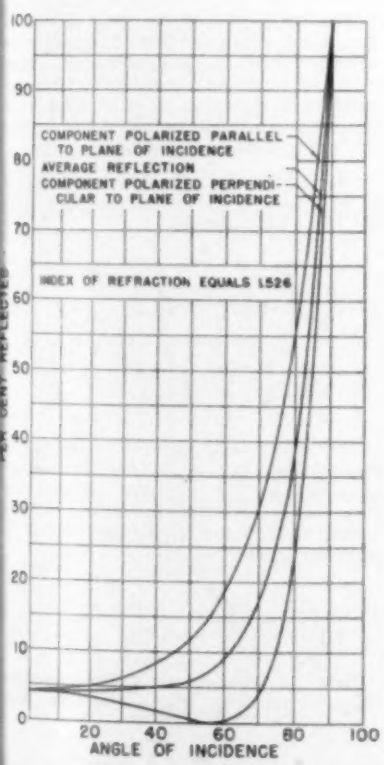

Fig. 7—Reflection of direct solar radiation from a single surface as a function of angle of incidence

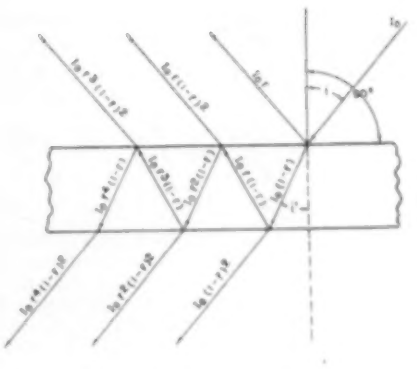

Fig. 8—Multiple reflections of direct solar radiation from a single sheet of glass

The total transmission, reflection, and absorption are found by evaluating Equations (18), (19), and (21) respectively, for each component and averaging. It can be seen from Fig. 8 that if the reflections beyond the second order are neglected, the transmission can also be expressed as follows:

$$T_1 = g (1-r)^2 \quad \ldots\ldots\ldots\ldots\ldots\ldots (22a)$$

This amounts to neglecting the value of $r^2 g^2$ in the denominator of Equation (18), and, as long as r is small, the error involved is negligible except at high angles of incidence as shown in Table 2. Inspection of Equation (12) shows that another approximation is possible if the g term is omitted from the series given by Equation (17) and then introduced as follows:

$$T_1 = g \frac{(1-r)}{(1+r)} \quad \ldots\ldots\ldots\ldots\ldots\ldots (22b)$$

Again only a small error is involved, as Table 2 shows. The error is greatest for glasses of high transmission value and at high angles of incidence.

Similar approximations can be made for the fraction of the incident solar radiation absorbed by single glass. From

Table 2—Comparison of the Transmission of Single Glass Calculated by Three Methods ($\mu = 1.526$)

Angle of Incidence	$KL = 0.054$			$KL = 0.837$		
	Eq (18)	Eq (22a)	Eq (22b)	Eq (18)	Eq (22a)	Eq (22b)
0 deg	0.868	0.883	0.877	0.396	0.404	0.401
40 deg	0.854	0.851	0.854	0.359	0.359	0.360
80 deg	0.415	0.362	0.426	0.134	0.130	0.153

Table 3—Comparison of the Absorption of Single Glass Calculated by Four Methods ($\mu = 1.526$; KL = 0.837)

Angle of Incidence	Eq (21)	Eq (23a)	Eq (23b)	Eq (23c)
0 deg	0.553	0.529	0.515	0.567
40 deg	0.584	0.544	0.547	0.603
80 deg	0.461	0.258	0.304	0.666

Equation (20) it follows that absorption may be expressed approximately as:

$$A_1 = (1-r)^2 - g\,(1-r)^2 \quad \ldots\ldots (23a)$$

or,

$$A_1 = \frac{(1-r)}{(1+r)} - g\,\frac{(1-r)}{(1+r)} \quad \ldots\ldots (23b)$$

or,

$$A_1 = (1-g) \quad \ldots\ldots (23c)$$

The degree of approximation of these three expressions is shown by Table 3, where the error is seen to be considerable. However, in the high transmission glasses there is so little absorption that the error is negligible except at high angles of incidence.

Double Glass

The method used in the preceding section can be used to calculate the transmission and absorption of two air spaced sheets of glass. The subscript 1 designates the outer glass, the subscript 2 designates the inner glass; the double subscript represents the combination. The series is set up in the following manner. The second sheet transmits T_2 times that transmitted by the first sheet or T_1T_2. The energy reflected by the second sheet followed by a re-reflection from the first sheet and transmission by the second sheet is $T_1R_2R_1T_2$. The next term is $T_2R^2_2T_1R^2_1$, and so on, so that

$$T_{1,2} = T_2T_1 + T_2T_1R_1R_2 + T_2T_1R^2_1R^2_2 + \ldots\ldots (24)$$

It follows then that

$$T_{1,2} = \frac{T_1T_2}{1-R_1R_2} \quad \ldots\ldots (25)$$

$$R_{1,2} = R_1 + \frac{T^2_1R_2}{1-R_1R_2} \quad \ldots\ldots (26)$$

$$A_{1,2} = \frac{[1-(R_1+T_1)]\,[1-R_2\,(R_1-T_1)] + T_1\,[1-(T_2+R_2)]}{1-R_1R_2} \quad \ldots\ldots (27)$$

However, in working out heat balances it is necessary to find the absorption of each glass separately. Hence,

$$A_1 \text{ of } {}_2 = \frac{[1-(R_1+T_1)]\,[1-R_2\,(R_1-T_1)]}{1-R_1R_2} \quad \ldots\ldots (28)$$

$$A_2 \text{ of } {}_2 = \frac{[1-(T_2+R_2)]\;T_1}{1-R_1R_2} \quad \ldots\ldots (29)$$

R, T, and A are calculated for single sheets as before and substituted in these equations. Inspection of Equation (25) shows that $T_{1,2}$ is expressed approximately as

$$T_{1,2} = T_1T_2 \quad \ldots\ldots (30)$$

This simplification breaks down when R_1 and R_2 become reasonably large, as they do at high angles, as shown by Table 4.

Again the error is greatest for glasses of high transparency and for incident radiation at the higher angles, where the R_1R_2 term in Equation (25) becomes appreciable. Similar approximations can be made for the absorption of energy by either the inner or outer sheet. Throughout this paper the exact equations, which require only one additional step, have been used.

Transmission and Absorption of Typical Glass

Since the primary purpose of this paper was to obtain data that could be useful in correlating test work with theory, Figs. 1 through 6 were prepared and have been presented in the main part of this report. It was necessary to examine typical glasses in order to determine both the index of refraction of window glass and the range of KL values that might obtain in practice.

Morey[16] gives the composition of a great variety of glasses. For window glass made by present day processes, the constituents are found in approximately the following percentages:

SiO_2	Na_2O	CaO	MgO	Al_2O_3	Fe_2O_3
70 to 73	12 to 15	9 to 14	0 to 3	0 to 1.5	0 to 0.15

For glasses having percentage compositions in the ranges given above, Morey gives values of the refractive index at the D line (sodium light) as between 1.502 and 1.549. Since the technical departments of the glass companies usually take the index as being 1.526 this value has been used in all calculations. However, the possible effect of variations has been studied and the results given in Appendix III.

The KL values were obtained by computation from transmission data for both plain and heat absorbing glasses furnished by a number of manufacturers. These data gave either the spectral transmission curves, or the transmission computed from this curve, or both, for normally incident radiation. Other data were obtained from the recent paper of Hottel and Woertz[1] and the earlier paper of Houghten, Blackshaw, and Gutberlet[2]. The transmission data given in reference 12 was computed by subtracting tabular values of percentages intercepted from 100. In this paper[12] the interception was attributed to absorption, but later studies at the ASHVE Laboratory[3] showed that reflection was chiefly responsible. The transmission data, however, are undoubtedly representative of the samples tested.

To date no systematic study has been made of standard grades and thicknesses of commercial window glass to determine the variability of their transmission characteristics. This is a part of the research project now in progress.

Table 5 gives transmission and absorption data from the sources just mentioned and listed in the last column. The numbers apply to bibliographic reference.

Except for the data ascribed to Hottel and Woertz[1], the g values were computed from data giving the transmission at normal incidence. Hottel and Woertz determined K by measuring the normal transmission of one or more plates of the same glass, cemented together to avoid reflection at the interfaces. Their paper refers to the variability of characteristics of pieces of glass of presumably the same grade and batch. Table 5 gives further evidence of that fact.

The g value of glass can be obtained by rearranging Equation (18) and solving for g as follows:

$$g = \frac{1}{2T}\left[-\left(\frac{1-r}{r}\right)^2 + \sqrt{\left[\frac{1-r}{r}\right]^4 + \frac{4T^2}{r^2}}\right] \quad \ldots\ldots (31)$$

This equation is awkward to use but if the second term inside the brackets be expanded by the binomial theorem, the first order approximation is accurate within about 0.1 per cent for normal incidence. Therefore,

$$g = T\left(\frac{1}{1-r}\right)^2 \quad \ldots\ldots (32)$$

This, of course, is simply equation (22a) rearranged. For angles other than normal incidence $\left(\frac{1}{1-r}\right)^2$ must be evaluated for each component of polarization and the arithmetical average determined.

Table 4—Comparison of the Transmission of Double Glass Calculated by Two Methods ($\mu = 1.526$; Both Sheets the Same)

Angle of Incidence	$KL = 0.054$ (one sheet) Eq (25)	$KL = 0.054$ (one sheet) Eq (30)	$KL = 0.419$ (one sheet) Eq (25)	$KL = 0.419$ (one sheet) Eq (30)
0 deg	0.756	0.754	0.365	0.362
40 deg	0.740	0.729	0.305	0.297
80 deg	0.250	0.172	0.141	0.117

Table 5—Characteristics of Some Glass Samples for Normally Incident Solar Radiation

Glass Type	Thickness L, inches	Per cent Transmission	g	KL	Absorption Coef K	Ref.
Single strength A quality	0.071	88.8	0.971	0.030	0.411	12
Double strength A quality	0.127	89.2	0.976	0.025	0.194	12
Clear Plate	0.270	87.2	0.954	0.047	0.174	12
Grade A	....	...	....	....	0.432	1
Water White	....	...	....	....	0.107	1
Tank Plate	0.243	77.5	0.848	0.166	0.683	13
Water White	0.259	88.4	0.967	0.033	0.129	13
Heat Absorbing, H_1	0.254	39.5	0.432	0.840	3.300	13
Heat Absorbing, H_2	0.129	43.5	0.476	0.742	5.750	13
Heat Absorbing, H_3	0.111	51.0	0.558	0.584	5.260	14
Heat Absorbing, H_4	0.247	34.0	0.372	0.986	3.990	14
Heat Absorbing, H_5	0.232	18.5	0.202	1.598	6.890	18

For normal incidence and an index of refraction of 1.526

$$g = 1.094T \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (33)$$

The results of this part of the analysis have been given in the form of curves in the main portion of the report. However, some discussion of them is appropriate here. Fig. 1 gives transmission values for single glass having an average index of refraction of 1.526 for KL values ranging from zero to 1.55. This adequately covers the practical range. Fig. 9 gives transmission values for a double glass combination in which the inner glass is double strength plain window glass of KL equal to 0.054. The outer glass may be any type ranging from $KL = 0.0$ to $KL = 1.55$. Fig. 3 gives similar values for double windows but with the abscissa as the sum of the individual KL values of each sheet. Actually the transmission of two windows requires separate calculations for each combination although the transmission is independent of the order in which they come. However, comparison of Figs. 3 and 9 shows that the error is negligible if the KL of each are summed and Fig. 3 is used.

In order to calculate the heat flow from the glass to the interior, it is necessary to know the glass temperature. This is a function of the indoor and outdoor temperatures and the absorption characteristics of the glass. Fig. 2 shows absorption plotted as a function of KL with angle of incidence as the parameter. It will be seen that absorption is substantially constant with incident angle for small KL values but that there is considerable change as KL increases. The percentage absorption for any type of glass is seen to be practically constant between 40 and 60 deg incident angle.

As stated before, the total absorption of a double glass combination is independent of the order in which the sun strikes the sheets. This is not true of the percentage absorbed by each. Presentation of the data becomes voluminous unless limitations are placed on the combinations. Fig. 4 shows solar heat absorption for various types of glass outdoors with one-eighth inch double strength plain glass (KL value of 0.054) indoors.

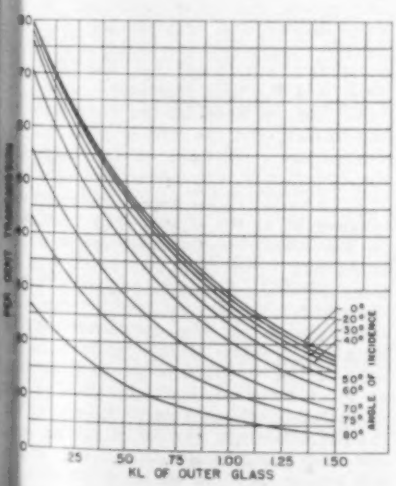

Fig. 9—Transmission of direct solar radiation by two sheets of glass when the KL of the inner sheet equals 0.054

Sky Radiation, Transmission, Absorption, and Reflection

In order to facilitate the analysis, the following assumptions were made: (1) that the radiation is uniform from all quarters of the sky and is independent of the position of the sun, and (2) that the polarization of the sky radiation is negligibly small.

Fig. 10 represents a window viewing one-quarter of the sky. Because the area of the window is small compared to that of the sky, i may represent the angle of incidence between the radiant ray from the unit sky area, dA_2 to any part of the window. If I_{os} represents the unit intensity of the sky radiation, the energy, dq, received by the window is proportional to the solid angle, dw, and the cosine of the angle of incidence, hence

$$dq = I_{os}\, dA_1 \cos i\, dw \quad \text{Btu per hour.} \quad (34)$$

But $\dfrac{dq}{dA_1}$ equals the unit energy, dE_s, received by the window from the sky and the solid angle, dw, equals $\dfrac{dA_2}{r^2}$. Over the whole quarter sphere at a fixed angle, i, dA_2 equals $\pi\ (r \sin i)\ (r di)$. The total energy, E_s, received per unit area of window from a sky of uniform unit intensity, I_{os} is found by integration over the quarter sphere.

The total fraction of sky radiation reflected, r_s, is the summation of the energy reflected at each angle divided by the total incident radiation. Since the fraction reflected at any one angle is a function of that angle, $r\ (i)$ and the plane of polarization, the fraction of the total sky radiation reflected is

$$r_s = \int_0^{\frac{\pi}{2}} \frac{r\ (i)\ \frac{\pi\, I_{os}}{2} \sin\ (2\, i)\ di}{\frac{I_{os}}{2}} = \int_0^{\frac{\pi}{2}} \pi\, r\ (i) \sin\ (2\, i)\ di \quad \ldots\ldots\ldots\ldots\ldots (35)$$

where $r\ (i)$ is expressed by Equations (9) and (10). Each expression was evaluated by plotting the intergrand as a function of i and then graphically integrating under the curve. The fraction reflected of the component polarized parallel to the plane of incidence was 0.154, which is equivalent to the reflection of a ray incident at 56 deg. The fraction of the other component reflected was 0.039, corresponding to the reflection of a ray incident at 69 deg.

The g term, found in similar fashion for two KL values, was simpler to integrate because the plot of the function was substantially a straight line. Table 1, given in the main part of this paper, lists the transmission, absorption, and reflection for several glass combinations calculated by means of the r and g values found in the manner described above and the formulas given in Appendix I.

Appendix II

Heat Transmission Due to Absorption and Temperature Difference

Heat Flow at the Indoor Surface of a Single Glass Sheet

The total heat flow through a glass window is the sum of the directly transmitted solar energy and the heat transferred from the inner surface to the indoor surroundings by convection and radiation. The latter is affected by the amount of solar and sky heat absorbed by the glass. In the report, Heat Transmission Through Windows and Glass Panels[3], the following heat balance is given for the steady state:

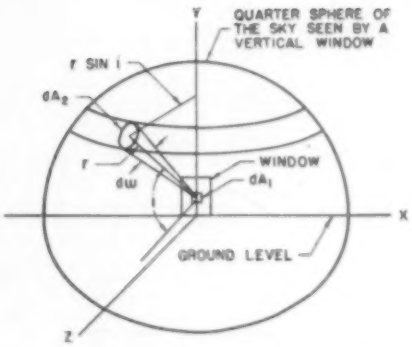

Fig. 10—Geometry of sky radiation on a vertical window

$$AI = h_{ro}\ (t_{so}-t_o) + h_{co}\ (t_{so}-t_{oa}) + h_{ri}\ (t_{si}-t_i) + h_{ci}\ (t_{si}-t_{ia}) \quad \ldots (36)$$

where

A = the fraction of the incident radiation absorbed

I = the incident radiation, Btu per (hr) (sq ft)

h_{ro} = outdoor radiation coefficient, Btu per (hr) (sq ft) (deg F)

h_{ri} = indoor radiation coefficient, Btu per (hr) (sq ft) (deg F)

h_{co} = outdoor convection coefficient, Btu per (hr) (sq ft) (deg F)

h_{ci} = indoor convection coefficient, Btu per (hr) (sq ft) (deg F)

t_{so} = temperature of outer surface of the glass, deg F

t_{si} = temperature of inner surface of the glass, deg F

t_o = temperature of the outdoor objects seen by the glass, deg F

t_i = temperature of indoor objects seen by the glass, deg F

t_{oa} = temperature of outdoor air, deg F

t_{ia} = temperature of indoor air, deg F

At this writing definite information is lacking regarding the exchange of heat by low temperature radiation between the glass and outdoor objects including the sky. Hence, h_{ro} and h_{co} will be lumped in a single coefficient, h_o, and t_o will be assumed equal to t_{oa}. Further it will be assumed that the glass temperature is uniform; thus $t_{so} = t_{si} = t_s$. It will also be assumed that $t_i = t_{ia}$. In some instances it will be convenient to combine h_{ci} and h_{ri} in a single coefficient, h_{cri}, a function both of mean temperature and temperature difference.

In arriving at the heat flow through single and double glass, an indoor temperature, t_i, of 80 F and an outdoor film coefficient, h_o, of 4.0 have been selected as being representative of average summer conditions. In the report cited[3], it was shown that the indoor film coefficient was the controlling factor in the normal flow of heat through glass and that considerable, say 20 per cent, variation could

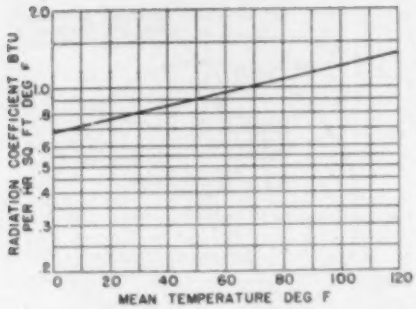

Fig. 11—Radiation coefficient as a function of mean temperature for $F_o \times F_s = 1.0$

in some instances be made in the outdoor coefficient without affecting the overall coefficient more than 3 or 4 per cent. This would not be true in the case of heat absorbing glass where the outdoor coefficient assumes more importance.

For the purposes of this paper, then, Equation (36) is written for single glass as follows:

$$AI = h_o (t_s - t_o) + h_{r1} (t_s - t_1) + h_{c1} (t_s - t_1) \quad \ldots\ldots (37)$$

The radiation heat transfer, Q_r, between the inner surface of the glass and its surroundings is given by the following equation:

$$Q_r = 0.173 F_o F_s \left[\frac{(T_s)^4}{(100)^4} - \frac{(T_1)^4}{(100)^4} \right] \quad (38)$$

The term $0.173 \left[\frac{(T_s)^4}{(100)^4} - \frac{(T_1)^4}{(100)^4} \right]$ can be divided by $T_s - T_1$ to obtain what can be called a radiation coefficient. As shown in the report[7] referred to above, this plots as a straight line function of the mean temperature, $t_m = \frac{t_s + t_1}{2}$, on semi-log paper. This is reproduced here as Fig. 11. T_s and T_1 are degrees F + 460.

The angle factor, F_s, for a window in one side of a wall which sees three other walls, the floor, and the ceiling, all at substantially ambient air temperature, is unity. The emissivity factor of glass has been taken at 0.94 (see McAdams[6]) and, if that of the indoor surfaces is taken as 0.85, the emissivity factor, F_e, becomes 0.80. The product of F_e times F_s times the appropriate coefficient taken from Fig. 11 gives the radiation coefficient, h_r.

It is assumed here that air circulation near the window on the indoor side is due entirely to natural means. Various authorities have correlated the heat transfer coefficient for natural convection by use of the difference between the surface and air temperatures raised to the 0.25 power. Hence, $h_c = C (t_s - t_1)^{0.25}$ where C is a constant depending upon the orientation of the surface. McAdams'[6] evaluation of C for vertical surfaces over 24 in. in height is 0.27. Colburn[8] as a result of his studies gives C a value of 0.30. In this paper McAdams' evaluation of 0.27 for convection heat transfer from a single vertical plate has been used.

Inspection of Equation (37) shows that the heat flow into the room, Q_{1s}, for single glazed windows may be expressed as follows:

$$Q_{1s} = AI - h_o (t_s - t_o) = h_{r1} (t_s - t_1) + C (t_s - t_1)^{1.25} \quad \ldots\ldots (39)$$

This equation shows that the heat flow is a function of the mean of t_s and t_1, since the value of h_{r1} depends upon this, and also the difference between t_s and t_1. Calculation of Q_{1s} (or Q_{out}, depending upon the temperatures) requires a trial and error solution of Equation (39) to determine t_s. This was carried out graphically by plotting Q against t_s for different combinations of AI, h_o, and t_o. The plot consisted of a series of straight lines, representing the left hand member of Equation (39), and a single curve, concave downward, representing the right hand member.

Fig. 5, given in the main portion of this paper, is a cross plot of the graphical solution of Equation (39) for an indoor temperature of 80 F and two different outdoor film coefficients, as indicated. For all practical purposes the lines are straight and have been so drawn. From these curves the U value, when no solar heat was absorbed, ranged between 0.98 and 1.09 for indoor temperatures of 70 or 80 F, an outdoor film coefficient of 4.0, and an outdoor temperature anywhere between zero and 100 F.

It is, therefore, sufficiently accurate to express the heat flow due to temperature difference and solar heat absorption combined as a fraction of the absorbed radiation plus the heat flow at zero heat absorption.

For $h_o = 4.0$:
$$Q = 1.04 (t_o - t_1) + 0.275 AI \quad \ldots\ldots (40)$$

For $h_o = 8.0$:
$$Q = 1.18 (t_o - t_1) + 0.15 AI \quad \ldots\ldots (41)$$

The fraction of the absorbed heat transmitted as given by each of these equations is an average for the conditions being considered. For example, it varied between 25 and 30 per cent for $h_o = 4.0$. It is substantially equal to the average U value divided by h_o.

Heat Flow from the Indoor Surface of Two Glass Sheets

This problem is complicated by the fact that each plate absorbs a different percentage of the incident radiation. This depends upon the characteristics and the order of arrangement of the two plates, although the total absorption is independent of the order. In the following equations each sheet of glass is assumed to be at uniform temperature. The subscript 1 refers to the outer glass and the subscript 2 refers to inner glass. Prime marks are used to designate the convection and radiation coefficients applicable to the heat exchange between the two glass sheets. Heat balances are written as follows:

$$A_1 I = h_o (t_{s1} - t_o) + C' (t_{s1} - t_{s2})^{1.25} + h'r (t_{s1} - t_{s2}) \quad \ldots\ldots (42a)$$

and

$$A_2 I + C' (t_{s1} - t_{s2})^{1.25} + h'r (t_{s1} - t_{s2}) = C (t_{s2} - t_1)^{1.25} + h_{r1} (t_{s2} - t_1) \quad \ldots\ldots (42b)$$

The heat flow into the room, disregarding the directly transmitted energy, can therefore be expressed as follows:

$$Q_{1s} = C (t_{s2} - t_1)^{1.25} + h_{r1} (t_{s2} - t_1 \quad \ldots\ldots (43)$$

$$Q_{1s} = (A_1 + A_2) I - h_o (t_{s1} - t_o) \quad \ldots\ldots (44)$$

In order to determine Q by either Equation (43) or (44), it was first necessary to determine t_{s1} and t_{s2} by methods like those used in the preceding section. It was also necessary to evaluate the constant C' for vertical air spaced plates. Present data in the HEATING, VENTILATING AIR CONDITIONING GUIDE[9] expresses the heat transfer across air spaces as a function of the mean temperature. This, however, does not take into consideration the fact that the temperature difference between the two surfaces forming the air space is an equally important factor. Rowley[4] gives results of guarded hot box tests of sheets of building board separated by air spaces of ½, 1, and 1½ in. Sufficient data were given so that the radiation contribution to the air space coefficient could be calculated and deducted. Average values of C equal to 0.211, 0.169, and 0.157 respectively were obtained. Griffith and Davis[17] found that the constant C averaged 0.19 for vertical plates spaced as indicated and decreased slightly as the space increased. Wilkes[9] gives a value of 0.18 for a 4 in. vertical space. On the basis of these data a value of C equal 0.18 was selected as being representative of air spaces likely to be encountered in practice. Fig. 6 in the main part of this report is a plot of the heat flow through double glass as a function of the amount absorbed by each sheet and the outdoor temperature. An indoor temperature of 80 F was used in these calculations.

Appendix III

Discussion of Data Used in Calculations

Outdoor Film Coefficient

An outdoor film coefficient of 4.0 Btu per (hr) (sq ft) (deg F) has been used tentatively by those interested in the mathematical analysis of periodic heat flow through walls and roofs[10]. Exactly what is a proper value to use is open to question. Forced convection coefficients for surfaces that appear in THE GUIDE 1945[9] (see Fig 1 and Chapter 4), were determined by experiments in which the test surface was installed near the end and in one side of a long duct. It has been shown[7] that this method does not entirely represent the conditions found in practice. Although the flow of air in ducts and the flow past surfaces such as walls are governed by the same laws, in the former case the flow is influenced by the enclosing surfaces of the duct. In the latter case this influence is lacking.

In order to more fully understand the importance of the outdoor film coefficient on the overall transmission coefficient of glass, new research is now under way at the ASHVE Research Laboratory at Cleveland. In this project the relationship between the film coefficient and the length of a single smooth surface, measured in the direction of air flow parallel to it, is being studied. In addition the effects of depth of window recess and of the projection and spacing of muntin bars are also being investigated. This study will reveal only the share of forced convection in the total coefficient.

Few data are available as to the rate at which an earthbound surface exchanges

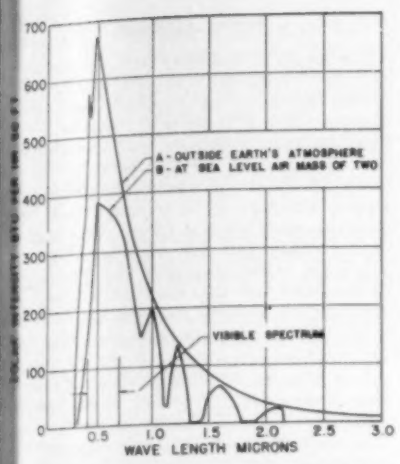

Fig. 12—Standard curves of direct solar radiation intensity on a plane normal to the sun's rays

low temperature radiation with the sky either by day or by night. Not until this effect has been studied can the outdoor film coefficient be properly evaluated. Evaluation of this effect is of fundamental importance to the whole field of estimating heat gains or losses of buildings. An indication of the importance of this point in any attempts at analyzing building heat flow is given by some test results of A. F. Dufton[11]. Large scale guarded hot box tests in which a single glazed glass roof was exposed to the weather revealed that the rate of heat loss in Btu per (hr) (sq ft) (deg F) in winter during the period between 5:30 P.M. and 9:30 A.M. ranged between 0.99 and 1.46 and averaged 1.16, while during the twenty-four hour period the coefficient ranged between 0.78 and 1.29, averaging 0.98.

Thermal Conductivity of Glass

In order to simplify the heat flow calculations given in the preceding sections, there was assumed to be no resistance offered by the glass itself and that, therefore, the temperature of the glass was uniform. The report on Heat Transmission Through Windows[7] summarized the results of a number of investigations of the thermal conductivity of glass. Values were as low as 2.0 and as high as 9.6 Btu per (hr) (sq ft) (deg F per inch). Since there was little evidence by which to judge the reliability of the data, a value of 6.0 will be used here. If this value obtains, and if the inside and outside film coefficients be respectively 1.5 and 4.0, the temperature differential through a quarter-inch thickness of glass is less than one degree under the usual summer conditions. For thinner sheets, of course, the differential is less.

Reflection of Solar Energy from Near Objects

In the analysis that has been made, no account was taken of the fact that solar radiation is reflected to a window from lawns, concrete pavements, and other outdoor surfaces. Unquestionably considerable radiation can emanate from such sources but present data are insufficient to justify an attempt to evaluate this effect.

Index of Refraction

In preceding sections it was pointed out that the index of refraction is a function of incident wavelength; this variation is known as dispersion. The International Critical Tables, Volume II, Page 104, give the dispersion of glass for three wavelengths. The possibility that this variation would affect the absorption and transmission of glass was tested for solar energy incident at a 75 deg angle on glass having a KL value of 0.419. At this angle $g = 0.576$. Table 6 shows the results obtained.

It is seen that variations in refractive index have but a minor effect on transmission, less than 2 per cent deviation on absorption, and that calculations based upon an index of 1.526 represent a good average.

Solar Energy Distribution and Its Relation to Transmission

Glass does not transmit all wavelengths equally well. This is particularly true of heat absorbing glass in the infra-red region. Since it is well known that the energy distribution of the solar spectrum varies with air mass (see Fig. 12 taken from the glass transmission report[7] and also Parry Moon's[8], Proposed Standard Solar Radiation Curves for Engineering Use), the integrated transmission factor for one energy distribution may not be correct for a different energy distribution. In addition the transmission of glass varies with wavelength as shown by Fig. 13, also taken from reference 7. As it has been pointed out, the energy distribution is also related to the barometric pressure of a locality, the precipitable water vapor in the atmosphere, and the dust concentration.

Spectral transmission curves were available for several heat absorbing glasses and several plate glasses. The transmission curves for an eighth-inch

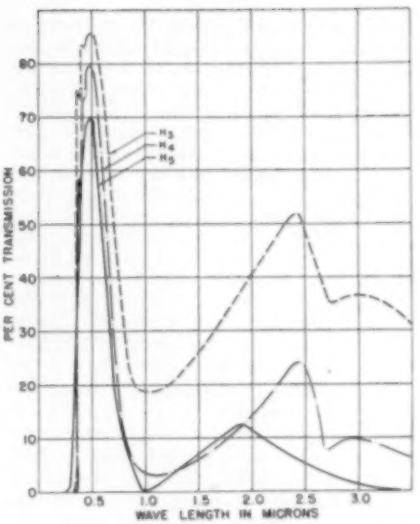

Fig. 13—Spectral transmission of direct normal solar radiation by typical heat absorbing glasses

heat absorbing glass and a quarter-inch plate glass were selected and the average transmission calculated for air masses of 1, 2, and 3. The energy available for each wavelength range was multiplied by the transmission for that range. The summation of these values taken at 0.1 μ intervals from 0.4 through 2.0 μ and divided by the total energy gave the fraction transmitted. The results given below in Table 7 show that the transmission is not significantly affected at normal incidence.

A third matter that requires consideration is the degree of polarization of the sky radiation. Sky radiation is solar radiation scattered by the air molecules, which are small compared to the wavelength. Since the ultra-violet radiation is shortest, the scattering of this radiation is greatest. The scattering effect has been found to be inversely proportional to the fourth power of the wavelength. Since the air molecules might well be considered as forming slits it is possible that the transverse vibrations in one direction would be suppressed to a greater extent than in the other. Such has been found to be true; the sky light is to some degree polarized. However, the difference is small enough that it can be neglected, particularly since the total energy is relatively small.

Solar Radiation Data

THE GUIDE 1945[9] at present incorporates tables of solar radiation on variously oriented surfaces. The values given in these tables (see Chapter 7, Tables 2, 3, 4 and 5) are the sums of the direct and the sky radiation. Because it was shown in the analysis presented in this paper that the direct radiation transmission depends upon the angle of incidence whereas the percentage of the total sky radiation transmitted does not, the two values should be considered separately. Further, in the report entitled, Heat Transmission Through Windows and Glass Panels[7] it was pointed out that while the solar data given in THE GUIDE was representative of Pittsburgh, it could not be considered representative of other localities.

Moon[8] has worked out standard solar

Table 6—Variation of T, A, and R with Refractive Index KL = 0.419; Angle of Incidence = 75 Degrees

Wavelength Microns	Refractive Index	T	A	R
2.00	1.490	0.342	0.367	0.291
0.89	1.526	0.341	0.362	0.297
0.28	1.560	0.340	0.356	0.304

Table 7—Variation of Transmission With Spectral Energy Distribution

Air Mass	1	2	3
	Transmission		
Heat absorbing glass $KL = 0.584$	0.521	0.510	0.501
Plate glass $KL = 0.166$	0.786	0.782	0.782

radiation curves in which the intensity is expressed as a function of air mass. Air mass simply refers to the thickness of the atmosphere and is very closely equal to the cosecant of the solar altitude. Obviously corrections are necessary for barometric pressure or altitude above sea level. These corrections are described in the report[7]. Fig. 14 reproduced here from the report shows Moon's recommended curve and data for Lincoln, Nebr. Also it shows the observations made at Pittsburgh, Pa., on which in part the present Guide data is based. Included is a plot of solar altitude versus air mass. A summary was made of the means of observations made over a period of years at Lincoln, Nebr.; Washington, D. C.; Madison, Wis.; and Boston, Mass. The observations for each of these stations for each air mass were averaged and in spite of differences in location and atmospheric conditions, the averages for the months of June, July, and August lie within 5 to 10 Btu of Moon's curve. The averages for September are markedly higher by some 15 to 25 Btu. The curve, however, must be used with discretion. For example, Albuquerque, New Mexico, values are as much as 50 Btu higher at certain altitudes.

Unfortunately, our information concerning sky radiation is meager. Fig. 15, reproduced from the report[7], gives some data on this point. Curves A, B, and C represent the best data. This subject is now under investigation by the Solar Radiation Section of the U. S. Weather Bureau. In the absence of more complete data, curve A is recommended for summer cooling load calculations.

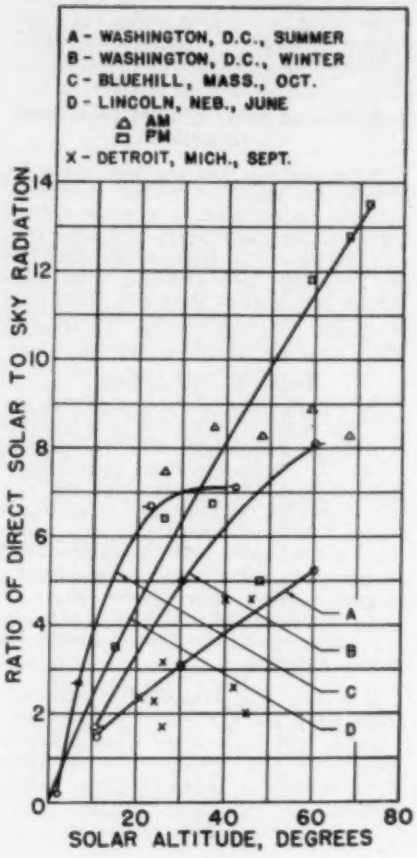

Fig. 15—Sky radiation on a horizontal plane

Solar Altitude

The angle of incidence of the sun's rays can be computed with the aid of well known formulae and astronomical observations. The altitude is a function of sun time, latitude, longitude, and the declination of the sun. Of considerable help in these computations are the following bulletins, which may be obtained from the Government Printing Office, Washington, D. C. They are the American Nautical Almanac, which includes the Ephemeris of the Sun; and The Azimuths of the Sun, Hydrographic Office Bulletin No. 71.

Typical of the convenient curves that can be drawn are those of Fig. 16, reproduced from an ASHVE Research Report[8]. The curves are for 40 deg north latitude and show solar altitudes for three dates. The angle between the sun's rays and the surface is given instead of the angle of incidence. Therefore, when Fig. 16 is used with data given in this paper, the angle must be subtracted from 90 deg.

Heat Storage

The analysis of solar heat transmission through glass would not be complete without an investigation of the heat storage effects of glass, particularly of those types known as heat absorbing glass. Because both the outdoor temperature and the radiation intensity are continuously changing, how much time elapses between the change of these conditions and their influence on the cooling system? Although the question cannot be answered exactly, an example of the effect of an extremely sudden change can be cited.

Let it be assumed that a one-quarter

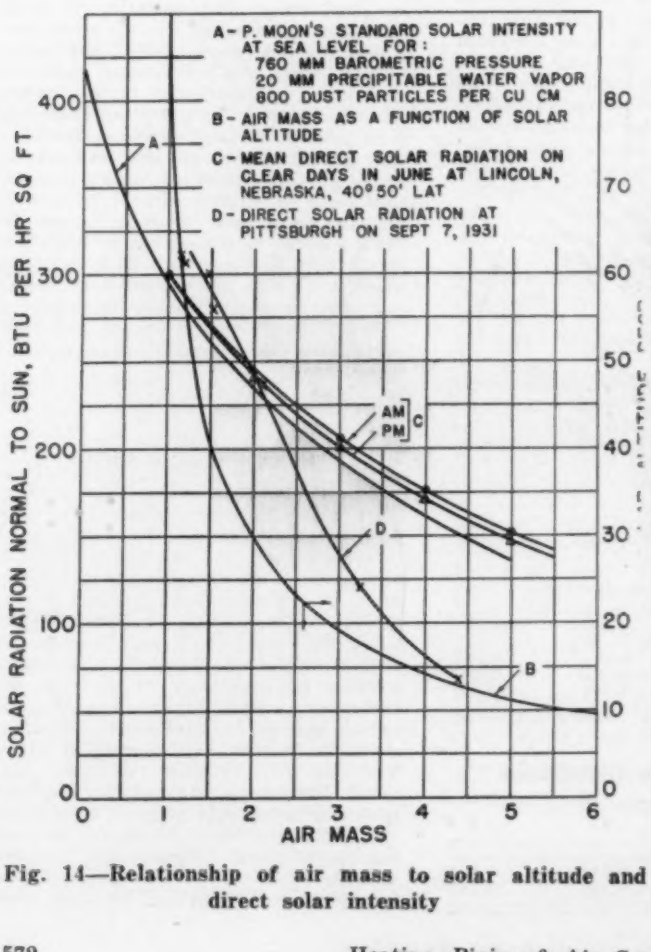

Fig. 14—Relationship of air mass to solar altitude and direct solar intensity

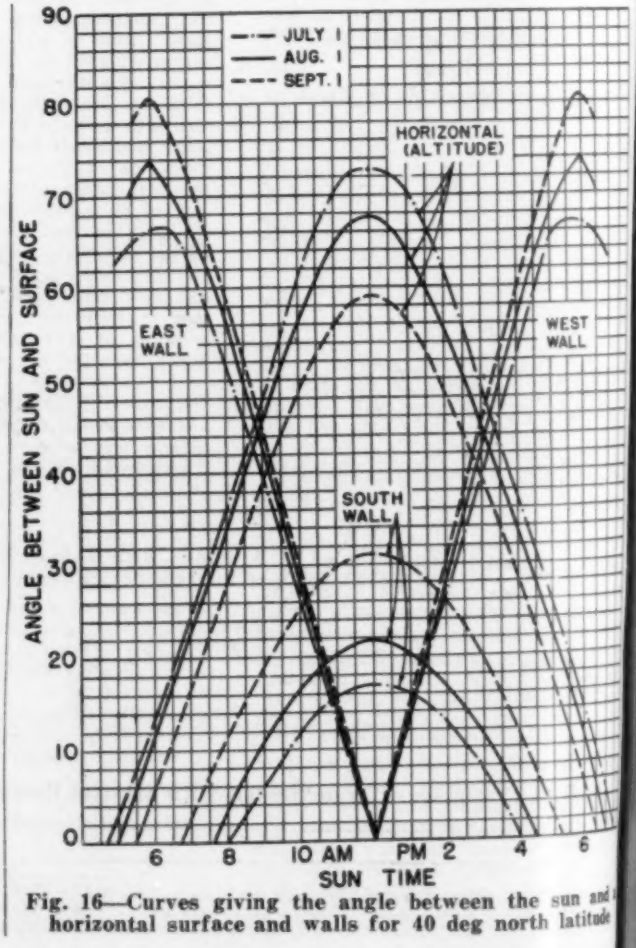

Fig. 16—Curves giving the angle between the sun and horizontal surface and walls for 40 deg north latitude

inch heat absorbing glass is at 87.6 F, the steady state temperature for 90 F outside and 80 F inside. Then assume that the glass is suddenly exposed to solar radiation of 200 Btu per (hr) (sq ft) intensity, 56 per cent of which is absorbed by the glass. This is equivalent to raising the outdoor temperature to 118 F.

For thin sheets of uniform temperature the following equation gives the relationship between the time and the sheet temperature:

$$\theta = \frac{\rho V C}{A} \ln \frac{B - At_1}{B - At_2} \quad \text{.....(45)}$$

where

θ = time, hours
ρ = specific weight, lbs per cu ft
C = specific heat, Btu per (lb) (deg F)
V = volume of sheet, cu ft
$A = h_o + h_{eri}$
$B = h_o t_o + h_{eri} t_i$
h_o = outdoor film coefficient (radiation and convection combined) Btu per (hr) (sq ft) (deg F)
h_{eri} = indoor film coefficient (radiation and convection combined) Btu per (hr) (sq ft) (deg F)
t_o = outdoor temperature, deg F
t_i = indoor temperature, deg F
t_1, t_2 = initial and final temperatures of sheet, deg F

In this example, it is assumed that $\rho = 148$, $C = 0.204$, $h_o = 4.0$, and $h_{eri} = 1.25$. As stated before, t_1 equals 87.6 F. The steady state temperature, 109 F, is reached in 34 min. This is, of course, an extreme case, one not likely to be encountered in actual installations. It is, however, important to consider in experimental work.

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16. Properties of Glass, by G. W. Morey. (Reinhold Publishing Co., New York.)

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18. Hobbie, E. H., Mississippi Glass Co., New York, N. Y., private communication, August 1945.

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DISCUSSION

Cyril Tasker, Cleveland, Ohio: Because war conditions at the time of preparation made it probable that this paper would not be presented before a regular Society meeting, a number of advance copies were sent to members of the Committee and to others interested in this general subject, together with an invitation that they contribute written discussion to be published with the paper. The comments received are therefore included together with the author's closure.

W. E. Zieber, York, Pa.: I think the form of this report is excellent. I believe the method of presentation wherein you put all of the pertinent data for examples and then illustrate its use with examples, will always be an excellent method of operation. The appendices explaining the various methods of attack appeal to me very much. I believe reports of this type, even though this is only a literature search correlating the information of such a search, will help immensely to prove to corporate managements that the ASHVE is getting down to hard pan on its research. The report is intelligible, leads to a logical conclusion, and presents information although not proven by experimental investigation. This information is useful as a guide as to what can be expected from such experimentation.

Some very interesting facts were presented, which I believe bring out some very important phases of the effect of glass upon cooling load calculations.

For cooling load calculations to design a system we need only the sum of the peak loads at the designated time of day. This might be a system designed for peak load at night or in the daytime.

Since glass causes an almost instantaneous load, it is important that the direct radiation and sky radiation, and the absorption ability of the glass be thoroughly evaluated by experimentation, in order to be certain of the practical side of their effects in cooling load calculations. We should also be sure that double windows are properly evaluated, both from the heat absorption and transmission standpoint.

If the sky radiation has a decided effect upon the north side of a building which has a lot of glass windows, this effect should be evaluated to see whether it must enter into the cooling load calculations.

If reflection of light enters this problem, it should be evaluated sufficiently to see what its heat load amounts to or what amount of heat load it prevents from entering the cooled space.

The present Guide data shows direct and sky radiation combined. The information contained in this bulletin would make it appear that these should be separated. I believe we should carefully weigh this point after we have evaluated sky radiation, because we should strive for simplification of calculations and not complications. I believe the numerical value of sky radiation is so small that it would be best to use it for an equivalent figure for direct radiation.

On the heat absorption by phase of glass, I am sure we need to know how much heat can be absorbed by so-called heat absorbing glass. It would appear from the paper that the temperature of the glass will rise, and in one of the cases mentioned it is shown it could rise from a 90 F outside ambient, with 80 F inside, from an 89 F glass temperature to a glass temperature of 109 F. If this is a fact, it would appear that heat is transmitted from the glass to the 80 F room, also from the glass to the outside 90 F ambient. Is it possible that the only heat prevented from entering the room with a heat absorbing glass is the amount that is transmitted from the 109 F glass to the 90 F outside ambient temperature? If this were the case then it would be necessary to have some facts on the glass temperature rise on so-called heat absorbing glass with certain sun intensities.

It was interesting to note from Fig. 14 the relationship between Pittsburgh and Lincoln data, in regard to solar intensity. There is only about 10 per cent maximum difference between 25 deg and 60 deg solar altitude. From 25 deg solar altitude down this difference increases rapidly, until at 12 or 13 deg solar altitude Lincoln is double Pittsburgh. This shows the effect of smoke and moisture in

the atmosphere is greater during the early part of the day, or the late part of the day, more so than when the sun is at its maximum altitude. This indicates the importance of having the proper solar radiation figures for the particular location. It may not have a great effect on glass calculations, but it will affect cooling load calculations considerably where the fly wheel effects of building materials and the cyclic unsteady state heat flow must be taken into account.

Since this analysis is made on the basis of unshaded windows, I believe we should know the effects of inside and outside shading, as well as the effects of different colors and different materials that might be used particularly in inside shades. This refers to any difference there might be between venetian blinds and materials used as draperies which might enclose a window to keep out the direct rays of the sun. It might be found that some types of inside shading of certain colors would be very highly effective in preventing the heat loads from the sun, or in reducing the total quantity of heat entering the cooled space. I believe this should be included in the study because the data now in the Guide shows that there are appreciable effects from shading windows and it is our desire to provide information which will reduce the cooling load to a minimum in all cases, with the minimum of expense to the building owner.

I have always been under the impression that the window recesses had an effect only as they shade part of the glass from the sun, and that all that should be counted is the amount of glass that is exposed to the sun's rays. It is possible that with heat absorbing glass convection currents will be established due to the heat of the glass, and in that case the depth of the window recesses may have considerable effect upon the motion of these convection currents and their velocity and also upon the velocity of the wind on the outside of the building as it strikes the glass. The deeper the recess the more resistant will it be to air motion tending to dissipate the heat. This could affect the external heat transfer coefficient of the glass and should undoubtedly be evaluated by some experimental work.

J. P. STEWART, Syracuse, N. Y.: Mr. Parmelee has earned the gratitude of air conditioning engineers by his thorough analysis of transmission of solar radiation through glass. We have an immediate use for the data on heat absorbing glasses and on double glazed windows. The data for a single layer of ordinary glass agree very closely with the best data we have available. We look forward with great interest to the experimental work now being conducted on solar heat transmission through glasses.

The following comments are intended to provide suggestions for future experimental work: I agree most heartily with Mr. Parmelee that there is a need for measuring the absorptivity to solar radiation for various colors used on window shades. These colors should at least include white, cream, tan, and green, used on roller shades, and aluminum, cream, and light gray paint commonly used on venetian shades. At the same time I think it would be desirable to obtain the absorptivity of various colors of paints used on the exterior of frame houses, as well as several colors of stone and brick. Experimental work to determine the effectiveness of various window shades should include white, cream, tan and green roller shades, and white cream, aluminum and gray venetian shades. Tests should be conducted with the plane of the slats parallel to the plane of the glass, as well as slats set at an angle of 45 deg with the plane of the glass. When light colored slats of venetian shades are turned parallel to the glass, the shades should be more effective in reducing the solar heat gain to the room because more solar energy is reflected to the outside rather than being directed into the room. In practice, perhaps the majority of venetian shades are adjusted so that the slats make an angle of 45 deg with the glass. Experimental work with outside venetian shades should include cream and light colors. I should also like to see tests on outside venetian shades with the slats painted white on the side exposed to the sun, but with the opposite side of the slats (on the inside) painted a dark color, like green. Theoretically, this two-color shade should be more effective in reducing the solar heat gain to the room than a shade painted white on both sides because less solar energy would be reflected from the inside surface of slats to the room.

I would like to see the Society analyze test data and recommend a design curve for solar radiation in summer which would be similar to Professor Parry Moon's curve A in Fig. 14. This curve probably would not be much different from that of Professor Moon's. Since this curve consists only of direct solar radiation, sky radiation should be added in order to get the total solar radiation impinging on any surface. Sky radiation should be measured on vertical and horizontal surfaces for all the hours during the day on several summer days. The only practical way to establish a design curve is to do so by measurement of solar radiation and I would suggest that the Laboratory consider obtaining this information in cooperation with the U. S. Weather Bureau. Perhaps such a design curve could be established from data already in the Weather Bureau records and from data available in the ASHVE Laboratory. The range of fluctuation of the solar constant rarely exceeds plus and minus 1 per cent. (Annals of the Astro-physical Observatory of the Smithsonian Institution, Vol. 6, p. 30.) The solar constant is the solar intensity incident on a normal surface located outside the earth's atmosphere and at a fixed distance from the sun, this distance being equal to the mean distance between the earth and sun. Because the earth is closest to the sun about January 1st, and farthest about July 1st, the solar intensity just outside the earth's atmosphere on January 1st is approximately 445 Btu per square foot per hour, whereas it is only 415 Btu on July 1st. The mean value of the solar constant is 430 Btu. The significance of this is that a design value of solar radiation selected for use in the United States in July should be increased approximately 7 per cent for use in the southern hemisphere in summer for January where the latitude is comparable to that of the United States. Direct solar radiation for the United States during clear weather in July is approximately 300 Btu on a surface normal to the sun at noon and at sea level; thus, about 28 per cent of the direct solar radiation is lost and scattered in passing through the earth's atmosphere. The principal cause for variation in solar intensity at the earth's surface is therefore due to atmospheric changes.

Examination of a curve published by the U. S. Weather Bureau (Review of U. S. Weather Bureau Solar Radiation Investigation—Irving F. Hand, Monthly Weather Review, December 1937) shows that this depletion of direct solar radiation in the atmosphere is caused by:

1. Atmospheric scattering, approximately 16 per cent, by air molecules, water vapor and dust;

2. Atmospheric absorption, approximately 12 per cent by oxygen, ozone, water vapor, carbon dioxide, dust, etc.

The foregoing 16 per cent and 12 per cent do not include an allowance for dust. The scattering and absorption caused by air molecules should be fairly constant for a particular elevation and solar altitude. If one considers a particular altitude and solar altitude, the principal factors which cause the solar radiation to vary at the earth's surface are water vapor, dust, ozone and carbon dioxide. For lower solar altitudes the amount of solar radiation scattered and absorbed in the atmosphere may be much greater than the 16 per cent and 12 per cent previously mentioned. Sky radiation is the portion of the scattered radiation which is directed toward the earth's surface, the remainder being directed into the vast space outside the earth's atmosphere. Probably ozone and carbon dioxide have relatively small effect in absorption and scattering, but by far the greatest variables are water vapor and dust. The depletion due to water vapor alone may be 10 or 12 per cent. However, this may be much more than 12 per cent under certain conditions. For a particular water vapor pressure at the earth's surface the amount of precipitable moisture contained in the atmosphere may vary as much as 200 or 300 per cent (Montezuma Pyrheliometry—C. G. Abbot, Monthly Weather Bureau Supplement No. 27, 1926).

There is, however, a definite relationship between any particular water vapor pressure and the corresponding average amount of precipitable water and I believe we would be more interested in average values. The desig-

solar radiation curve should not consist of the averages of all days during the summer months but should consist *only of averages on certain days when the dewpoint is within 5 deg of the dewpoint corresponding to the design dry-bulb and wet-bulb temperatures.* Only relatively clear days should be included. The depletion due to dust may be even greater than that due to water vapor.

Solar radiation data should be analyzed over a period of several months, in June, July, August and September, and a basic curve established from data obtained by one or more stations located in the Middle West in a region relatively free from dust, elevation of station not to exceed 1000 ft. Also similar data should be obtained in several of our industrial cities, such as Pittsburgh, Chicago, St. Louis, to determine the range of a multiplying factor to apply to this basic curve which would apply to cities. This multiplying factor may be in the order of 0.90 or perhaps 0.80 in some instances, depending upon the amount of smoke present. This total solar radiation (direct plus sky) in Boston, Massachusetts was 12 per cent less than at Blue Hill (Blue Hill is only ten miles south of Boston, and elevation is 300 ft higher than Boston). This comparison was made at noon on certain days when the sky was clear in both Boston and Blue Hill. Data should also be analyzed from a station near the Gulf, in Texas or Florida and from a station located near sea level in a semi-desert or desert country. Data should also be obtained from stations at approximate elevations of 5,000 and 3,000 ft. Albuquerque, New Mexico would be a very suitable station for the 5,000 ft elevation.

I recommend the use of another Hydrographic Office publication, No. 214, *Tables of Computed Altitude and Azimuth* which gives the solar altitude and azimuth angles direct for various hours without having to make calculations. This publication consists of five volumes which include latitudes from 0 to 49 deg inclusive, each volume consisting of 10 deg of latitude. This book may be purchased from the Superintendent of Documents, Government Printing Office, Washington, D. C., at a price of $2.25 per volume. It is necessary to use the American Nautical Almanac to obtain the declination of the sun for the day and month desired.

L. K. JONES, Pittsburgh, Pa.: The writer of this paper has dealt with an extremely complex set of physical phenomena by means of mathematical treatment condensed in the form of curves which are the common language of the architect and engineer. It is, however, hoped that even further simplification with a sufficiently close approximation can be derived for usage in actual practice, since the computation as shown in the example given over a cooling season would become extremely bulky.

The use of the term *direct solar radiation* as given in Figs. 1, 2, 3 and 4 might be stated more exactly. For instance, it is not clear to the reader why, in the example given the *direct normal solar radiation* (283 Btu) was multiplied by the cosine of the angle of incidence to obtain the *direct energy* in the fourth paragraph of the solution, which was again multiplied by a 73 per cent factor derived from Fig. 1. It would appear from the discussion in Appendix I that the value of *direct solar radiation* referred to in Fig. 1 was the intensity in the path of the ray, and the reduction by the cosine of the angle of incidence before using this step should be unnecessary. However, if the cosine term were not used, the transmitted energy would increase by over 50 per cent which is probably incorrect.

The author states in this paper and in a former report, that the indoor film coefficient would be the controlling factor in normal heat flow, and that a 20 per cent change in the outdoor film coefficient would cause only a 3 or 4 per cent effect on the overall coefficient (U). However, it should be borne in mind that to secure an increase in inside film coefficient of 20 per cent would call for a change in air movement at 1/3 mph of from 200 to 300 per cent, while to change the outside film coefficient, the same amount at, say, 15 mph would only call for a 28 per cent increase in velocity. While it is true that because the inside film coefficient in a building is initially smaller by a four or five to one ratio, it should also be pointed out that the chances of wide variation would in turn be much less likely than for the weather side of the windows. As a matter of fact, when variations in wind velocities such as experienced in practice from practically still air to 20 or even 30 mph are considered, the control might easily change from the inside to the outside of the window.

J. EARL FRAZIER, Washington, Pa.: My criticism of this paper covering work done by the author during the past months, can be confined in most part to mere explanatory terms.

I should like to see the weight of the glass sheets described as grams per square centimeter or ounces per square foot, or described as a definite limit of variation between the weight of the sheets.

At the last meeting of the Committee on Glass which was held at Boston in January of this year almost everyone in attendance was in accord that more experimental work must be done on low temperature radiation. This is partially brought out in the transcript submitted to me.

Generally speaking, the paper should be helpful to engineers concerned with heating and cooling, and also with the moving of air.

H. B. VINCENT, Toledo, Ohio: This paper contains many worthwhile ideas but we feel that it is open to the following criticism.

The analysis is quite correct but the data on solar radiation are so meager that we question the accuracy of the results. However, if adequate information concerning the intensities of solar, ground and sky radiation become available, this method of analysis will be very valuable. The direct measurement of the intensities of solar radiation is not extremely difficult and average values could readily be found for a number of localities. These, combined with the present paper would comprise valuable engineering information.

H. C. DICKINSON, Washington, D. C.: This paper appears to contain a thorough analysis of the subject in regard to plain, vertical, unshaded windows. I have a feeling that the paper is a little too thorough for the purposes of engineering design. In general, there is too much stress on the need for accurate data, considering the fact that meteorological conditions vary so widely and have a great effect on heat transmission through windows.

I have not checked all the equations in detail, but the general methods involved in their derivation are sound. Referring to Fig. 11, the author states that this is a straight line when plotted on semi-log paper against the arithmetical mean temperature. This is only approximately true.

The author takes the emissivity of the inside walls, floor and ceiling of a room as 0.85. It should be practically unity, since so far as radiation to or from a window is concerned, the whole interior is essentially a black body.

AUTHOR'S CLOSURE: The writer wishes to express his appreciation to Messrs. L. K. Jones, Pittsburgh, and E. W. Conover, Detroit, and Dr. H. C. Dickinson, Washington, who called the writer's attention to several minor errors in the original draft which were corrected. He also appreciates the suggestion in a letter from J. N. Livermore, Detroit, that it should be emphasized that although the order in which two unlike sheets of glass are placed makes no difference in the percentage transmission or absorption, the order does make a difference in the rate of heat transfer from the inner glass. This is explained by the fact that while a given combination absorbs the same percentage regardless of order, the percentage absorbed by the inner sheet is affected by the percentage absorbed by the outer. Equations 27, 28, and 29 show this.

Mr. Jones has brought out the point that there may be some misinterpretation of the term *per cent transmission* as used in Figs. 1, 3, and 9. Since this is expressed as a function of KL with angle of incidence as a parameter, the reader might assume that the term also allows for the reduction of the intensity of radiation normal to the sun's rays by the cosine of the incident angle. Such is not the case. Either the direct radiant energy per square foot of glass area is multiplied by the appropriate transmission percentage, or the direct radiation per square foot area normal to the sun's rays is multplied by the cosine of the incident angle and the appropriate transmission percentage to obtain the rate of radiant energy transmission per square

foot of glass area. The same reasoning applies to the term *per cent absorption.*

Although the reduction of the per cent transmission by the cosine of the incident angle would simplify the computation, particularly if data similar to Fig. 14 were used, the writer has drawn curves of the total rate of heat flow through a given type of glass, including the effects of sky and direct radiation and temperature difference. These rates of heat flow are expressed as functions of the direct radiation and the parameters, angle of incidence and temperature difference. When more definite information regarding the variations in the transmissivity of commercial glasses has been obtained, these curves can be made available.

Similar curves for shaded windows will undoubtedly require a third parameter, azimuth, to properly express these transmission characteristics. The percentage reduction by shades is by no means constant, as reference to Research Report No. 1180* will indicate. Considerable fundamental data on the absorptivity of types and colors of surfaces are required, as pointed out by several contributors to the discussion.

The writer agrees with Messrs. Stewart and Zieber that one of the most important problems facing the Society is the establishment of proper radiation curves for various localities. Particular attention should be given to sky radiation, particularly if the data are to be used in computing heat gains in the so called solar houses. The analysis given in this paper, however, is not, as Mr. Vincent suggests, dependent upon accuracy of solar radiation data. Spectral distribution of energy, as pointed out in Appendix III, has a negligible effect on the results.

Mr. Jones' comments with regard to the share of the outdoor and indoor film coefficients are well taken. The writer's statement was based upon the design wind velocity of 15 mph and the recommended outdoor coefficient of 6.0 Btu per (hr)(sq ft)(deg F). Low wind velocities would alter considerably the heat transfer rates from the surface of the glass to the indoors, if considerable solar heat were absorbed. This can be illustrated by Equations 40 and 41.

Dr. Dickinson has stated that the curve given in Fig. 11 is not exactly a straight line. This is true, but for all practical purposes it may be considered so and was drawn so. There is actually a very slight curve in the points and for that reason it should not be extrapolated. The maximum deviation from a straight line is about 1 per cent. With reference to the emissivity of the interior of a room, the emissivity factor of a room and window combination is given by the expression $Fe = \dfrac{1}{1/e_1 + A_1/A_2\ (1/e_2 - 1)}$

where e_1 and e_2 are the emissive powers of the glass and the room surfaces respectively, and A_1 and A_2 are their respective areas. If glass has an emissive power of 0.94, this value is also the limiting *Fe* factor for large rooms. For small rooms *Fe* may approach 0.80. The angle factor, *Fa*, is unity if the window is in one wall only, since it is then totally enclosed. If there are windows in more than one wall, this factor becomes less than unity. Possibly a value of 0.90 for *FeFa* would have been a better compromise than 0.80. Obviously if the space were totally enclosed by glass, all of which was at the same temperature, the heat transfer from the glass by radiation would be zero. A number of tests of the overall transmission coefficients of single windows have been made in guarded hot boxes, the surfaces of which were covered with reflective aluminum foil. The results were roughly 50 per cent lower than those obtained by tests where *black* surfaces were used.

*Heat Gain Through Western Windows With and Without Shading, by F. C. Houghten and David Shore. (ASHVE TRANSACTIONS, Vol. 47, 1941, p. 251.)

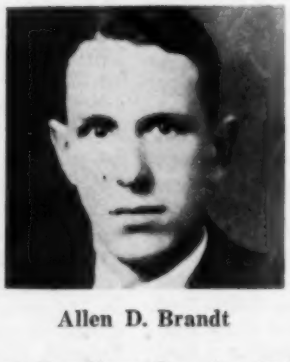
DR. BRANDT AT ASHVE RESEARCH LABORATORY

On October 1, Allen D. Brandt, Sc.D., Senior Sanitary Engineer, U. S. Public Health Service, commenced his duties at the Society's Research Laboratory to conduct studies involving the relationship of air conditioning and ventilation to industrial hygiene.

His assignment was authorized by the U. S. Public Health Service and is welcomed by the Committee on Research.

Dr. Brandt is a native of Pennsylvania, was graduated from Penn State College in 1931, and received the Rockefeller Foundation Fellowship for advanced work in industrial hygiene at Harvard University, where he studied under Professors Philip Drinker and C. P. Yaglou. His research and thesis for the doctorate were in the field of air conditioning and health.

From 1933 to 1940, Dr. Brandt was director of the Industrial Hygiene Research and Development Laboratory of Willson Products,



Allen D. Brandt

Inc., at Reading, Pa. In 1940 he was appointed to the Reserve Corps of the Public Health Service, and to the Regular Corps in 1941. From 1941 until his assignment to the Army late in 1942, he was Chief of the Engineering Unit, Industrial Hygiene Division, U. S. Public Health Service. In his assignment with the Ordnance Department, he was responsible for the overall supervision of the engineering phases of the industrial hygiene program in about 90 Army-owned plants employing over 475,000 workers manufacturing, loading, and storing explosives. In this capacity he assisted greatly in the design of adequate ventilating systems for the control of atmospheric health hazards affecting thousands of workers, and contributed substantially to the splendid health record made by the Army Ordnance Department.

He joined the ASHVE in 1940, has been active on several technical advisory committees, has written extensively in the technical press, and has presented papers before the Society.

SON TO THE FLEISHERS

Mr. and Mrs. Walter L. Fleisher, New City, N. Y., are receiving congratulations upon the birth of a son, Jeffrey Alexander Garrick Fleisher, on September 11, at Doctors' Hospital, New York City. Mr. Fleisher is president of Air & Refrigeration Corp., New York, and Mrs. Fleisher is well known as Marcia Garrick, writer and grower of herbs. Mr. Fleisher promises to nominate his new son for ASHVE membership at the earliest possible date.

A New Friction Chart for Round Ducts

By D. K. Wright, Jr.,* Cleveland, Ohio

This paper is the result of research carried on by the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS at its Research Laboratory located at 10700 Euclid Avenue, Cleveland

INTRODUCTION†

The second project listed in the Research Booklet published by the Society in the fall of 1944 was entitled "Air Friction in Ducts and Fittings." The purpose was given as follows:

"Accurate, dependable, and widely acceptable data on air friction in ducts and fittings, resulting from studies sponsored by the Society, would prove a distinct help to the designing engineer. Such data would reduce the necessity for the use of liberal factors of safety, and, by improving design, should reduce the time now needed for elaborate balancing tests to insure satisfactory working of the system.

"Only data generally accepted as reliable by the industry should carry Society sponsorship; data now being used have not earned general acceptance, and the reason for it deserves careful study. Doubtful values must be checked experimentally under competent direction."

In the listing of the specific objectives of this work the first one was given as "The correlation of existing data from all reliable sources and a comparison of results obtained by various experimenters in the light of the methods used in determining the data."

This paper is the result of preliminary studies made by the Society's Research Laboratory on the first objective. The work was carried out under the general direction of the Technical Advisory Committee on Air Distribution and Air Friction†† and the specific direction of a subcommittee consisting of R. D. Madison, chairman; S. H. Downs, L. P. Saunders, K. H. Flint, H. F. Hagen and L. L. Simmons.

The services of Prof. D. K. Wright, Jr., of Case School of Applied Science were secured for this work since all senior members of the Research Laboratory staff were fully occupied on other projects.

The investigation showed that recent work in the field of fluid mechanics had resulted in data of a high degree of accuracy having general acceptance. However, as far as the ventilating engineer was concerned, these data were not in a form in which he could use them readily for design purposes.

Prof. Wright has taken these fundamental data and developed an air duct friction chart from them. To make it readily usable by ventilating engineers it follows the same form as the charts which have been used in the past. Its acceptance by the Society and its use to replace the present Society chart (TRANSACTIONS, Vol. 45, 1939, p. 52, and THE GUIDE 1942-1945) is recommended by the Technical Advisory Committee on Air Distribution and Air Friction.

This is but the first in a series of papers to be presented from the Research Laboratory as the program is developed. Rectangular equivalents of round ducts, and the effect of various types of construction on the friction factor are next in line for attention. The resistance to the flow of air imposed by the chief types and sizes of duct fittings and transitions now in use will receive early attention.

Purpose of This Report

ONE OF THE important problems attending the design of any ventilating or air conditioning system is that of providing satisfactory duct work. In some instances this problem means the balancing of first costs and operating costs; in others, it means obtaining the required flow of air with low enough fan and air speeds to avoid objectionable noise. A vital part of the solution rests in a satisfactory estimate of the flow resistance offered by the system.

The total resistance to the flow of air through an air handling system is made up of the following: 1. Resistance of straight duct runs; 2. Resistance of fittings and transformations; 3. Resistance of grilles, registers, and dampers for controlling air flow; 4. Resistance of equipment—coils, filters, etc.

This paper is concerned only with the resistance of straight ducts and is further restricted to round ducts. It is the result of a survey and subsequent discussion of the problem by the Subcommittee on Air Duct Friction of the Society's Technical Advisory Committee on Air Distribution and Air Friction. The important companion subject of conversion from round to rectangular cross-sectional duct of the same capacity and resistance is to be investigated and reported on later.

In 1938, a research project was initiated at the ASHVE Research Laboratory (then in Pittsburgh) to provide basic data on the resistance to flow of air in sheet metal ducts, for the purpose of checking the friction chart then in general use by the Society. The laboratory made an extensive series of tests on round ducts, 4, 8, and 24 in. in diameter, with and without joints, and on several sizes of rectangular ducts. Two papers were presented, one in 1939,[1] and the other in 1940.[2] The former contained two friction charts developed from the experimental data, and in 1942 one of these charts (that is, the one for straight round duct with 40 joints per 100 ft and with no factor of safety allowed) was incorporated in THE GUIDE and has been used since that time.

From the time of publication of the first paper, it was known that the Laboratory values were somewhat lower than duct friction values in general use, and, in the case of the ducts without joints lower than any previously reported. Criticism of the new chart indicated the advisability of a resurvey of the problem, which was undertaken by the Committee on Air Distribution and Air Friction, resulting in the present paper. Its purpose is to offer a new air friction chart with an explanation of the basis on which it has been constructed.

Basic Theory of Flow In Closed Pipes

The problem of resistance to flow of a fluid in a closed straight round conduit is most simply attacked by the use of non-dimensional groupings of variables as follows:

$$If\ h = \frac{L}{D}\frac{V^2}{2g} \quad \ldots\ldots\ldots\ldots (1)$$

where h=head loss due to friction in feet of the fluid flowing

L=conduit length in feet

D=conduit inside diameter in feet

V=fluid velocity in feet per second

g=acceleration due to gravity, 32.2 fps squared,

*Asst. Prof. of Mechanical Engineering, Case School of Applied Science.

†Introduction by Cyril Tasker, Director of Research, ASHVE.

††Ernest Szekely, *Chairman*; S. H. Downs, S. L. Elmer, Jr., K. H. Flint, W. H. Hoppmann, II, F. J. Kurth, J. N. Livermore, D. J. Luty, R. D. Madison, Prof. L. G. Miller, Prof. D. W. Nelson, Prof. G. B. Priester, L. P. Saunders.

[1]Exponent numerals refer to Bibliography.

then f is the non-dimensional friction coefficient which for isothermal flow at the velocities used in ventilating work is known to depend on just two other non-dimensional groups; the Reynolds Number,

$$R = \frac{VD}{\nu}$$

(ν = kinematic viscosity of the fluid in sq ft per second), and the relative roughness,

$$\frac{\epsilon}{D}$$

of the conduit surface, where ϵ is a roughness measure having the same dimension as that used for the diameter, D.

For very low Reynolds Numbers —below 2000—the fluid motion is laminar, and f is found to depend only on R being independent of roughness as long as it is not so extreme as to cause an effective reduction in diameter. This range is relatively unimportant in ventilating work. For an intermediate range of Reynolds Numbers, f depends on both R and

$$\frac{\epsilon}{D}$$

while for high Reynolds Numbers, the flow becomes completely turbulent, f becomes independent of R and depends only on relative roughness. Almost all the operating conditions under discussion here fall within the intermediate transition region between laminar and completely turbulent flow. The variations of the friction factor with both Reynolds Number and relative roughness are, therefore, of importance in the present discussion.

One of the early investigators to recognize the dependence of the friction coefficient on Reynolds Number, and to use the now familiar f versus R chart was Blasius[3] who, in 1913, plotted a considerable body of experimental data for smooth drawn pipes at values of R between 3000 and 100,000 on log-log coordinates. He decided that a straight line fitted the data and proposed an equation of the type,

$$f = \frac{A}{R^a} \quad \ldots\ldots\ldots\ldots\ldots\ldots (2)$$

This relation is the basis for the commonly-seen equations giving the head loss in terms of the velocity of flow to some power less than 2, for if it is substituted in Equation (1), we obtain

$$h = \frac{A}{R^a}\frac{L}{D}\frac{V^2}{2g} = \frac{A\nu^a}{(VD)^a}\frac{L}{D}\frac{V^2}{2g}$$

$$= KL\frac{V^{2-a}}{D^{1+a}} \quad \ldots\ldots\ldots\ldots\ldots\ldots (3)$$

Values of a in common use run from 0.14 to 0.20.

The effect of change of relative roughness with duct diameter is frequently accounted for by further modifications of the exponent of the diameter. This equation is the basis for most of the air duct friction charts now in existence. Its use amounts to an assumption that the log-log f-R chart is made up of a series of parallel straight lines, one for each relative roughness.

In contrast, *test results* have indicated that the f-R chart should not be such a series of straight lines, but rather, a set of curves, concave upward, fanning out, and approaching zero slope at very high Reynolds Numbers. A short length of any one of these curves may successfully be approximated by a straight line as found by Blasius, but when the range of Reynolds Numbers and relative roughnesses covered by the usual friction chart is considered, it is not hard to understand the difficulties encountered with a chart based on Equation (3).

In 1933, the results of the analysis by Pigott[4] and Kemler of most of the data available on pipe friction were published, the final form being a log-log f-R plot made up of various broken straight lines for different degrees of roughness. At about the same time, Nikuradse[5], von Karman[6], and Prandtl[7] published theoretical and experimental work which defined the flow in smooth pipes, and in rough pipes for complete turbulence; and in 1939, Colebrook[8] succeeded in developing a functional form now believed to be satisfactory in the transition zone.

Taking advantage of these theoretical developments, Rouse[9], and, recently, Moody[10] have rebuilt the Pigott chart. Moody's form, originally published in the *ASME Transactions*, November, 1944, is reproduced here as Fig. 1. Since it is recognized by authorities in the field of fluid mechanics as being based on the best information now available, this graph has been used in computing values for the new air friction chart.

Basis for New Chart

In order to use Fig. 1, the Reynolds Number of the flow and the duct roughness must be known. The Reynolds Number has been computed for standard dry air at 29.92 in. Hg barometer and 70 F, taking the kinematic viscosity, ν, corresponding to these conditions at 16.3×10^{-5} sq ft per second.

To determine a satisfactory estimate of the roughness of average sheet metal duct, a survey of published test results on ventilating type ducts, and of existing friction charts has been made. This investigation is summarized in Appendix I. As a result, the roughness measure, ϵ, of clean, round galvanized sheet metal duct with about 40 slip joints per 100 ft has been taken as 0.0005 ft and this value has been used in making up the chart as shown in the sample computation, Appendix II.

The proposed air duct friction chart is presented in Fig. 2. The conditions under which it may be used are stated in the accompanying caption. The effects of changes in air conditions or duct materials are discussed herewith.

It will be noticed that the duct diameter and air velocity lines in Fig. 2 are curved. This is, of course, the result of using the curved friction factor *vs.* Reynolds Number relations from Fig. 1 rather than the straight line Equation (3). A comparison of the new chart with several others in use at the present time is given in Table 1 and in Figs. 6 and 7. The agreements and disagreements are presented there more forcefully and more succinctly than can be done in words.

Adaptation of Chart to Changed Conditions

Two types of changes might occur from those conditions assumed in constructing the chart; changes of duct material or roughness, and changes of air conditions. Figs. 3, 4, and 5 give some indication of the deviations in duct roughness normally to be expected. The largest deviations of points from the curves drawn are of the order of 10 per

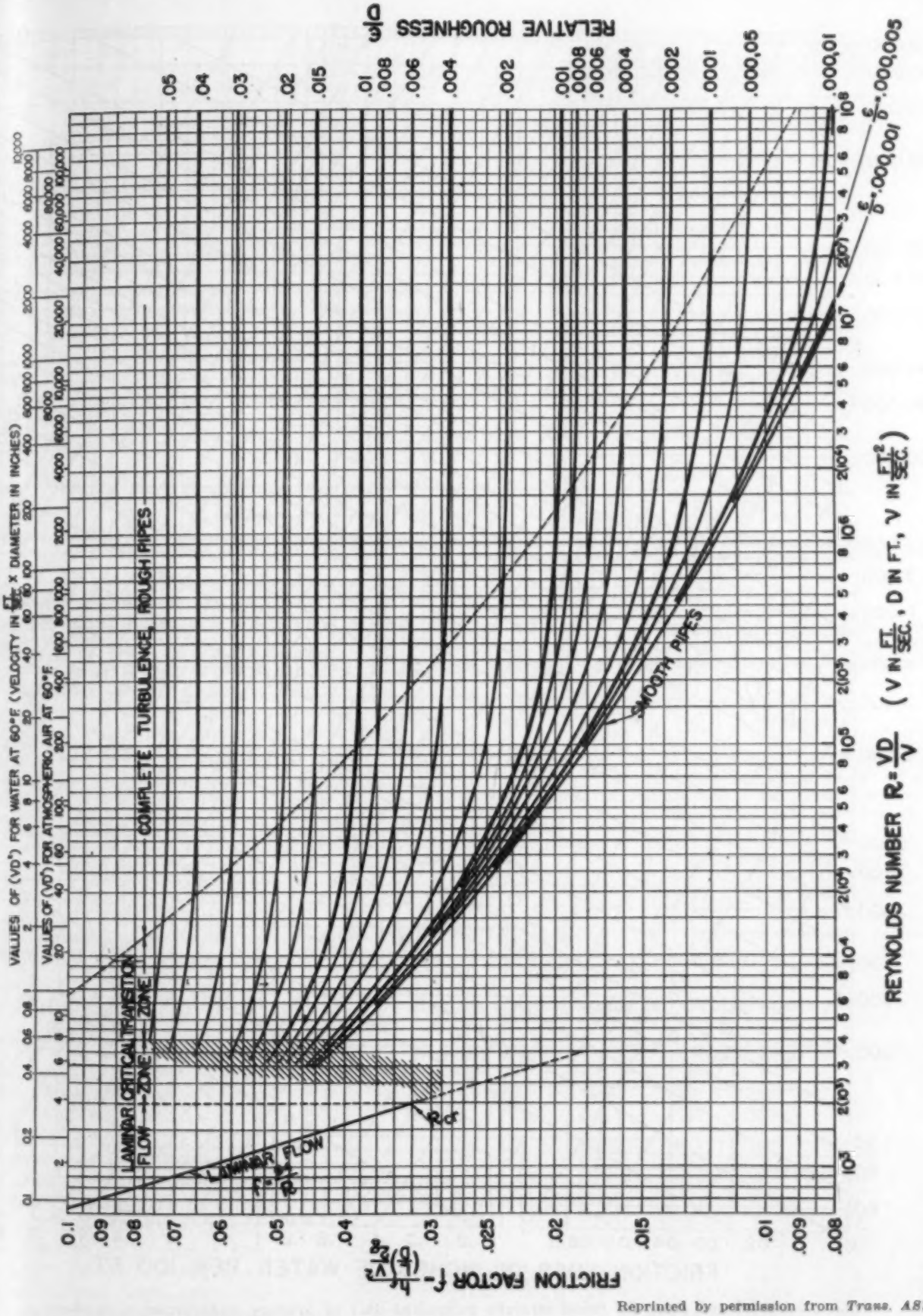

RELATIVE ROUGHNESS $\frac{\epsilon}{D}$
.05 .04 .03 .02 .015 .01 .008 .006 .004 .002 .001 .0008 .0006 .0004 .0002 .0001 .000,05 .000,01
$\frac{\epsilon}{D}$=.000,001 $\frac{\epsilon}{D}$=.000,005
VALUES OF (VD') FOR WATER AT 60°F (VELOCITY IN $\frac{FT.}{SEC.}$ x DIAMETER IN INCHES)
VALUES OF (VD') FOR ATMOSPHERIC AIR AT 60°F
LAMINAR CRITICAL TRANSITION FLOW ZONE
COMPLETE TURBULENCE, ROUGH PIPES
SMOOTH PIPES
LAMINAR FLOW
$f=\frac{64}{R}$
REYNOLDS NUMBER $R=\frac{VD}{\nu}$ (V IN $\frac{FT.}{SEC.}$, D IN FT., ν IN $\frac{FT^2}{SEC.}$)
FRICTION FACTOR $f=\frac{h_f}{\frac{L}{D}\frac{V^2}{2g}}$
.1 .09 .08 .07 .06 .05 .04 .03 .025 .02 .015 .01 .009 .008

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Fig. 1—Friction factor in relation to Reynolds number and relative roughness

cent. The ultimate in smoothness obtainable with sheet metal duct is of the order of $\epsilon = 0.000,005$ ft, a result obtained from some unpublished data by J. R. Weske on 6 in. galvanized duct with very carefully fitted flanged joints. This roughness is about the same as that for smooth drawn tubing. Friction is,

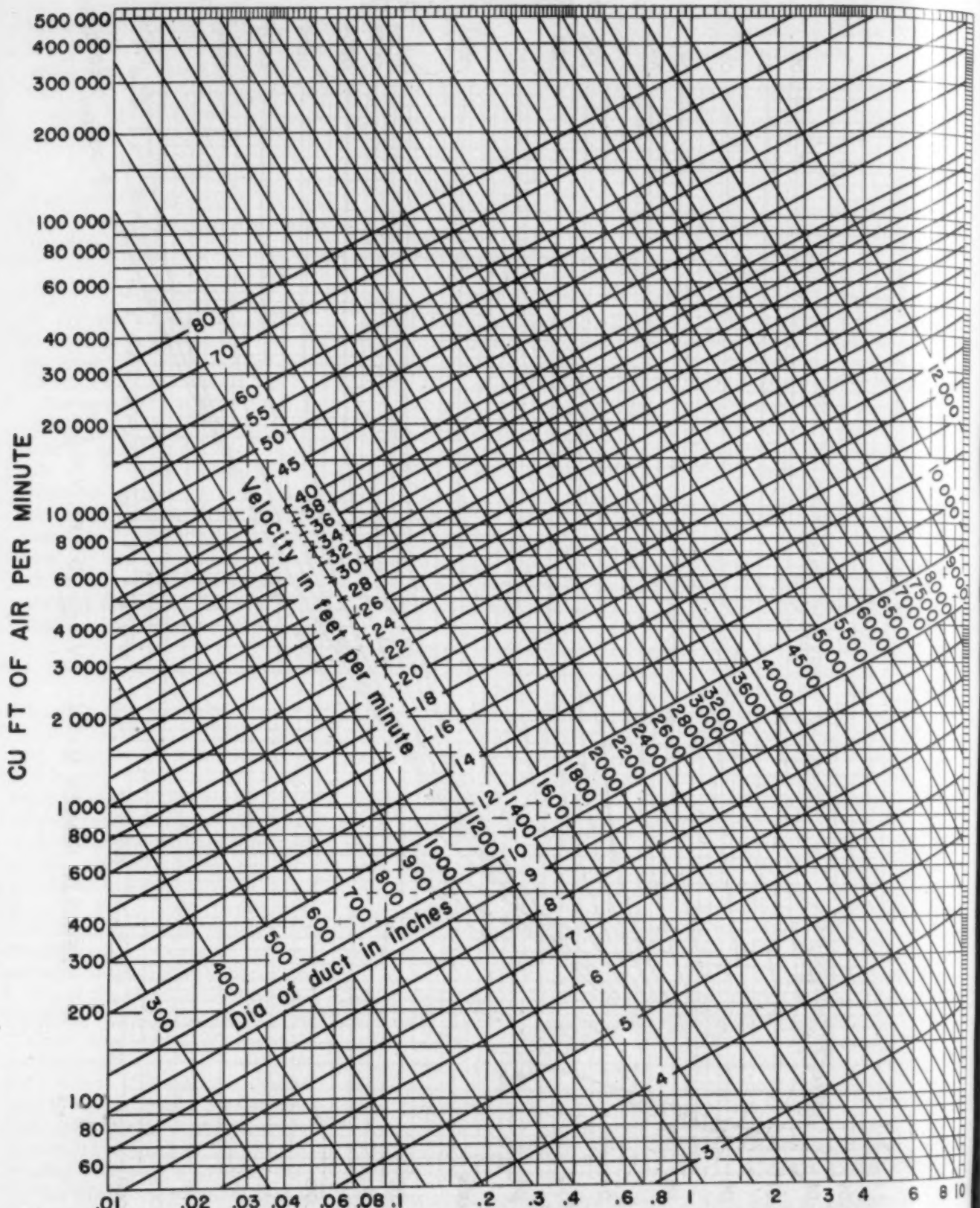

Fig. 2—Air friction chart for round straight galvanized duct of average construction with about 40 joints per 100 ft based on dry air at 29.92 in. barometer and 70 F

therefore, very sensitive to joint frequency and construction.

Fig. 2 has been made up for average construction and might be expected to give results accurate to within ∓ 5 to 10 per cent. For duct materials having greatly different roughness it has been common practice to apply a factor to friction loss values read from the chart; in other words, to make a constant percentage correction. Ex-

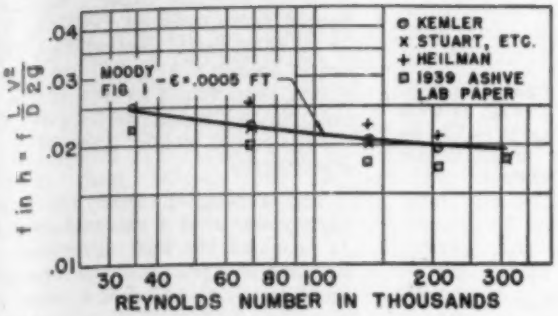

Fig. 3—Comparison of Moody data (Fig. 1) with test data—8 in. galvanized duct with joints

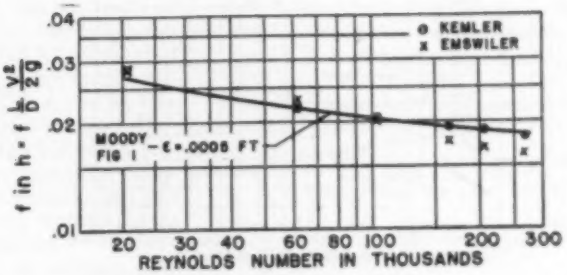

Fig. 4—Comparison of Moody data (Fig. 1) with test data—12 in. galvanized duct with joints

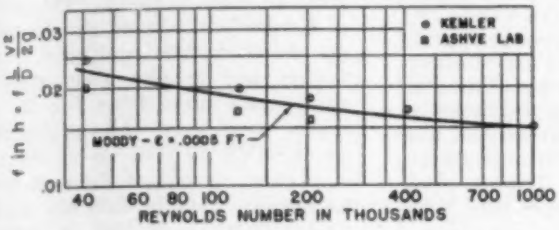

Fig. 5—Comparison of Moody data (Fig. 1) with test data—24 in. galvanized duct with joints

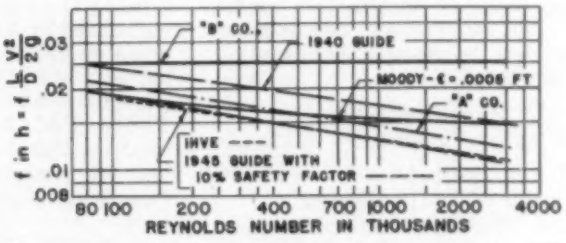

Fig. 6—Comparison of Moody data (Fig. 1) with friction charts—24 in. galvanized duct with joints

amination of Fig. 1 shows this procedure to be very undesirable since the change in friction factor from one line of relative roughness to another is small where the factors are high and large where they are low. The best solution to the problem would be to have several different charts for the materials most frequently used or to work from Fig. 1 as indicated in Appendix II.

Changes in air conditions—temperature, pressure, humidity—affect friction values first by changing the kinematic viscosity, hence the Reynolds Number and the friction factor read from Fig. 1; second, by changing the specific weight used in the conversion of units from feet of air to inches of water.

Changes in humidity produce changes in kinematic viscosity and density which are small enough to be disregarded in duct design. Temperature and pressure variations affect kinematic viscosity and specific weight in opposite directions, and thus tend to be compensated, although the change in specific weight is more powerful an influence on duct friction than the accompanying change in kinematic viscosity.

As a result, the following statements appear justified:

1. Usual variations in barometric pressure or in pressures required to circulate air through low pressure duct systems have negligible effect on duct friction.

2. Variations in air temperature of the order of ± 20 F from 70 F affect duct friction to a small enough extent to permit the use of Fig. 2 without correction.

3. The only theoretically correct method of making corrections for changes in either air conditions or duct roughness is recalculation from Fig. 1, using the new conditions. The Colebrook function, used in plotting Fig. 1, is expressed as:

$$\frac{1}{\sqrt{f}} = -2\log_{10}\left(\frac{\epsilon/D}{3.7} + \frac{2.51}{R\sqrt{f}}\right)$$

a particularly cumbersome expression from the standpoint of separating the variables. It is unlikely that a simple means of correcting the duct friction chart can be worked out of this relation.

Summary

1. Following a survey of available literature, and using the newest theoretical developments, a new air duct friction chart has been worked out and is presented in Fig. 2.

2. Because of a lack of test data on large ducts, the upper end of the chart is still subject to some uncertainty. The Committee and the author are anxious to receive the comments and suggestions of those whose ex-

Table 1—Comparison of Duct Friction Charts

Air Velocity—FPM	Source	Friction Loss in Inches of Water per 100 ft Duct Diameter—In. 5	10	20	40	80
500	1940 Guide	0.14	0.058	0.024	....	....
	1945 Guide[a]	0.11	0.045	0.019	....	....
	IHVE	0.11	0.044	0.018	....	....
	A	0.11	0.048	0.020	....	....
	B	0.093	0.047	0.023	0.012	....
	Fig. 2	0.11	0.044	0.018	0.0080	....
1,000	1940 Guide	0.51	0.21	0.086	0.036	....
	1945 Guide[a]	0.40	0.17	0.066	0.027	0.011
	IHVE	0.38	0.16	0.066	0.028	0.011
	A	0.40	0.17	0.073	0.031	0.013
	B	0.38	0.19	0.095	0.050	0.023
	Fig. 2	0.37	0.16	0.068	0.029	0.012
2,000	1940 Guide	4.0	1.7	0.67	0.27	0.12
	1945 Guide[a]	3.0	1.3	0.51	0.21	0.085
	IHVE	....	....	0.49	0.21	0.082
	A	3.0	1.3	0.55	0.22	0.10
	B	3.4	1.7	0.85	0.42	0.21
	Fig. 2	3.0	1.3	0.54	0.24	0.10
10,000	1940 Guide	....	....	5.8	2.4	0.98
	1945 Guide[a]	....	11.	4.4	2.0	0.78
	IHVE	....	....	....	....	....
	A	....	12.	5.0	2.2	0.90
	B	....	....	9.3	4.6	2.3
	Fig. 2	....	13.	5.7	2.5	1.1

[a]Recommended 10 per cent safety factor included.

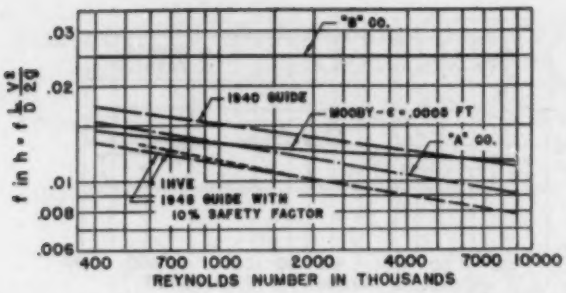

Fig. 7 — Comparison of Moody data (Fig. 1) with friction charts — 72 in. galvanized duct with joints

perience in this range may help to resolve the doubt.

3. No simple theoretically sound method exists for adapting the readings from the chart to extensive changes in air or duct surface conditions. A satisfactory approximate method may be possible, but remains to be developed.

Acknowledgments

The author gratefully acknowledges the help he has received from each of the following.

1. The Technical Advisory Committee on Air Distribution and Air Friction, particularly the Subcommittee on Air Duct Friction, for discussion and suggestions on the decisions reached in the paper.

2. Cyril Tasker and the staff of the Research Laboratory, in particular, Miss Doris Dietz who calculated and drew the friction chart and prepared figures (except Figs. 1, 8, and 9) for publication.

3. Prof. G. L. Tuve for helpful criticisms.

4. Prof. L. F. Moody and the *American Society of Mechanical Engineers* for permission to reproduce Figs. 1 and 8.

5. Prof. L. G. Miller and the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS for permission to reproduce Fig. 9.

APPENDIX I
Summary of Published Data on Duct Friction

The purpose of this survey of the literature was to gather enough actual test data to decide what value of ϵ best represented the surface roughness of round sheet metal duct of average construction. An unsatisfactorily small amount of such data was uncovered, none of it on duct larger than 24 in. in diameter. This is naturally the result of the equipment size and expense involved in testing large sized duct at high velocity.

It must be admitted that the decision reached is not as certain as might be desired, but it is felt that the final results are closer to the truth than those obtained in the past by simple extrapolation of the original data. The uncertainty lies in whether the absolute roughness, ϵ, of the duct surface is constant for all sizes or increases with increasing diameter. This is discussed in greater detail below.

The data examined and presented here in Figs. 3, 4, and 5, were obtained from published work by Emswiler[11], Kemler[13], Heilman and McArthur[12], Houghten, Schmieler, Zalovcik, and Ivanovic[1], and Stuart, Warner, and Roberts[14]. All except the material from Kemler are the results of actual tests by the authors. The values recommended by Kemler have been given equal weight because of his outstanding work with Pigott in correlating all the data available on pipe friction to 1933[15]. Prof. L. G. Miller has also used the Pigott chart for duct design, but his recommended friction coefficients are slightly higher than Kemler's.

In his original paper[13], Kemler reported some work by Petit on 10 and 13 in. sheet metal duct which indicates much higher roughness (ϵ = 0.001 to 0.005) than found by any of the others. Since Kemler has not given these results much weight, they have been disregarded.

The conclusion from the present survey was that a value of ϵ = 0.0003 ft provided the best agreement with the data analyzed, and the lines drawn on Figs. 3, 4, and 5 are taken from Fig. 1 to indicate that agreement.

Still another comparison, with air duct friction charts now in use, is given in Figs. 6 and 7. The method of comparison selected was to reduce the charts to their equivalent friction factors and to plot them with the appropriate curve from Fig. 1. The charts used were, that published in the ASHVE GUIDE up to 1941; the new chart developed from Research Laboratory data in 1939 and used in THE GUIDE from 1942 to 1945; the

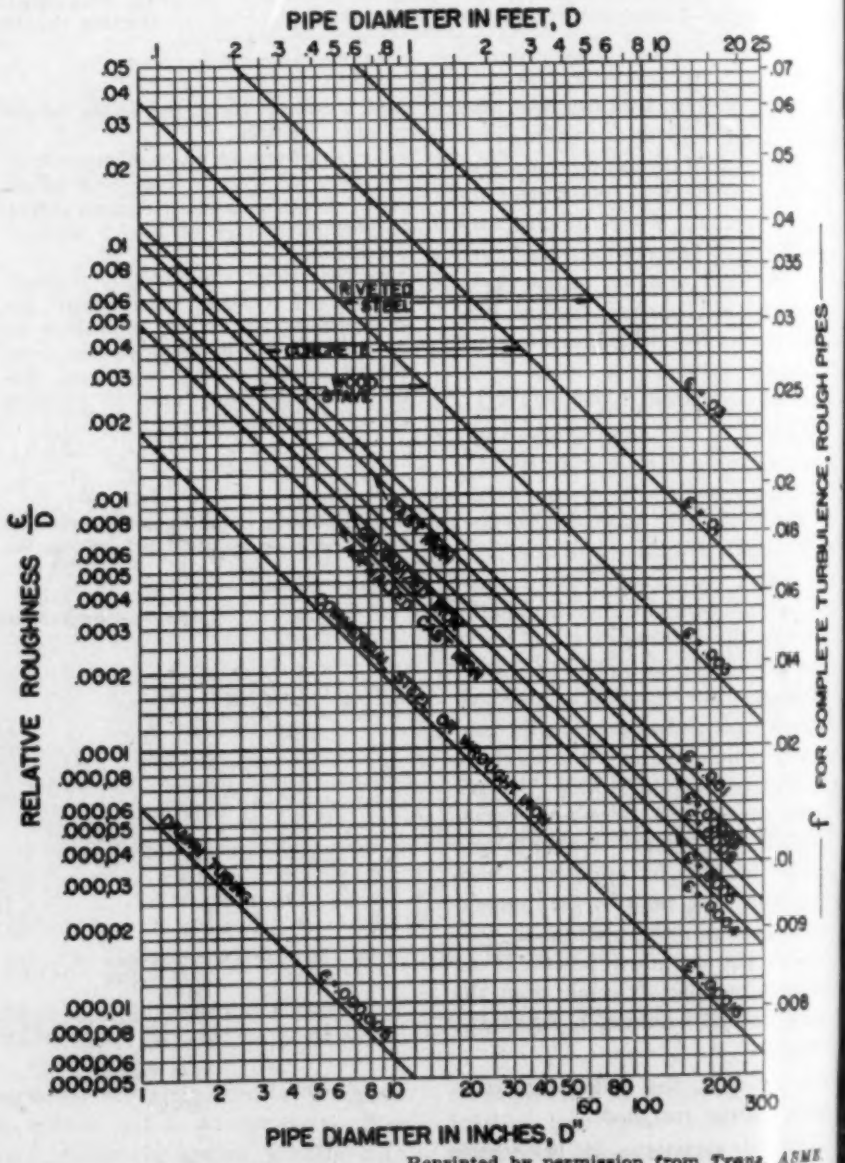

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Fig. 8—Roughness factors for various pipe materials

chart of the British Institution of Heating and Ventilating Engineers, and charts used by two companies in the field, labeled here, A and B. Since working values were obtained from all other charts, the recommended 10 per cent safety factory has been applied to those taken from THE GUIDE 1945. The *B* chart is an old one computed from a constant friction factor of 0.025.

Figs. 6 and 7 have been drawn over the range of Reynolds Numbers covered by the charts. The effect of using a straight line, constant slope equation is clearly indicated here. In Fig. 6, the slopes of all the lines, and the magnitudes of THE GUIDE 1945 and *IHVE* values are not greatly different from those of the curve of Fig. 1 at low Reynolds Numbers—the range in which test results are available. At the higher velocities, however, the deviation is serious, and the results of too extreme extrapolation of test data are apparent.

Fig. 7 was drawn to compare the charts at the upper end where test results are lacking. The indication—that the values given in the chart in the 1939 paper (1942-1945 GUIDE chart) are too low, that a better value would fall between *A* and THE GUIDE 1940 charts, and far below the *B* chart—is not unexpected, and falls to throw any doubt on the proposed method.

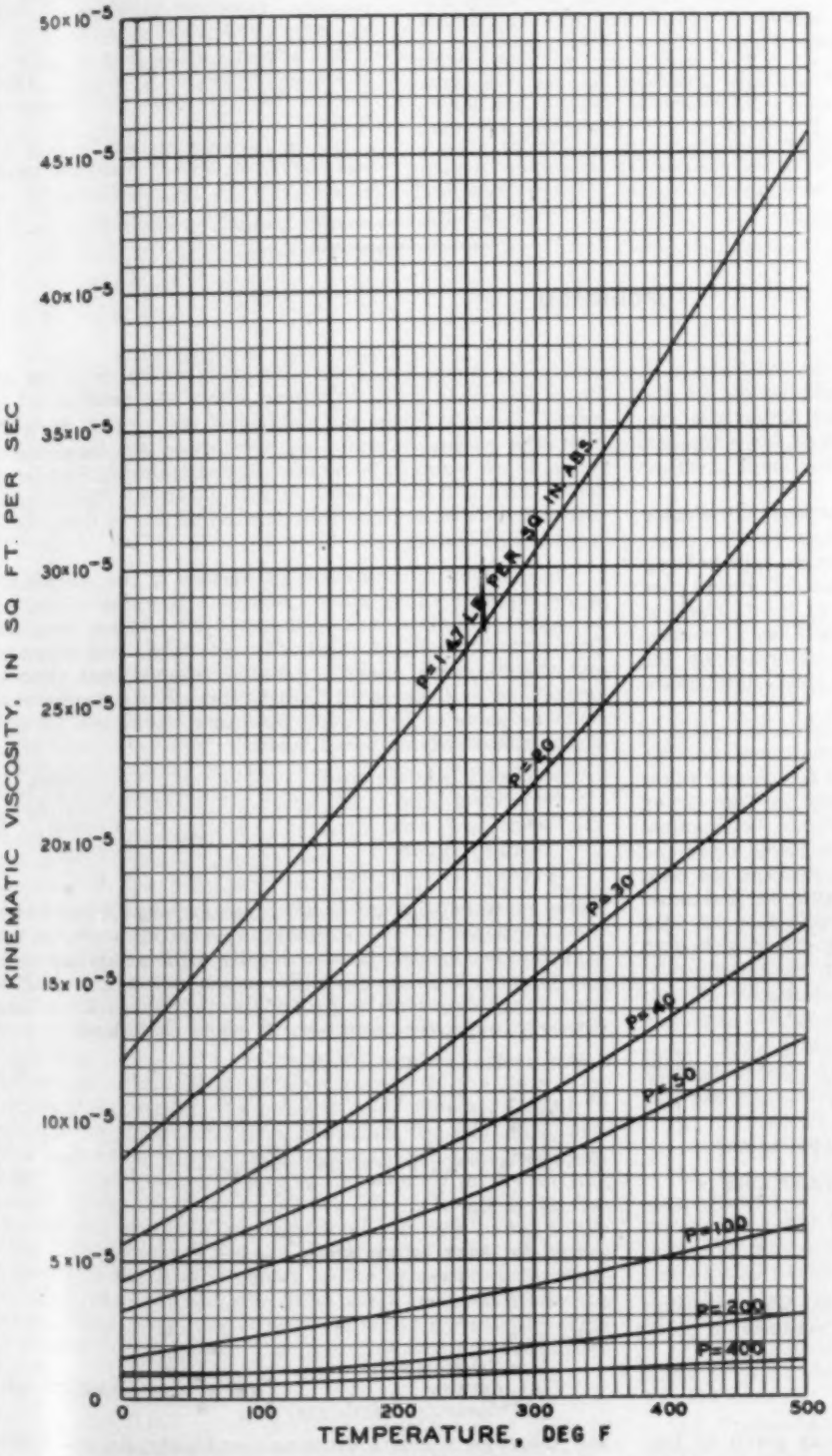

Fig. 9—Curves for determining kinematic viscosity

Conclusions

1. For duct sizes up to 24 in., test results indicate that round, galvanized, sheet metal duct with approximately 40 joints per 100 ft has a surface roughness represented by $\epsilon = 0.0005$ ft on Fig. 1.

2. No test results are available at large diameters to indicate whether surface roughness changes with diameter or not. Comparison with existing friction charts with consideration of the reputations of those charts furnishes a rough check that the assumption of constant ϵ may not be far from the truth.

APPENDIX II
Sample Calculation

As an example of how the new chart, Fig. 2, was computed and to indicate the method of using the basic data presented here, the following problem will be solved:

> What is the friction loss in inches of water of dry air at 70 F and 14.7 psi absolute flowing through average clean sheet metal duct 100 ft long and 16 in. in diameter at a velocity of 1400 fpm?

The duct diameter in feet is $16/12 = 1.33$.

For average sheet metal duct assume $\epsilon = 0.0005$ ft. Then the relative roughness,

$$\frac{\epsilon}{D} = 0.0005/1.33 = 0.000375.$$

(This value can also be obtained from Fig. 8 which is reprinted from Moody's paper in the *Transactions of the American Society of Mechanical Engineers*[10]. Fig. 8 also suggests values of ϵ to be used for a number of other pipe or duct surfaces).

The Reynolds Number, R, of the flow must be determined in order to read the friction factor from Fig. 1.

$$R = \frac{VD}{\nu}$$

where

$$V = \text{fps} = \frac{1400}{60} = 23.3$$

$D = \text{ft} = 1.33$

$\nu =$ Kinematic viscosity, sq ft/sec.

The kinematic viscosity can be read from Fig. 9, reprinted from L. G. Miller's paper on duct design[10].

For 14.7 psi absolute, and 70 F, $\nu = 16.3 \times 10^{-5}$ (from Fig. 9)

Hence

$$R = \frac{VD}{\nu} \times \frac{23.3 \times 1.33}{16.3 \times 10^{-5}} = 1.91 \times 10^{5}$$

From Fig. 1 corresponding to $R = 1.91 \times 10^{5}$ and $\frac{\epsilon}{D} = 0.000375$

read $f = 0.0182$

Then the head loss in feet of air,

$$h = f \frac{L}{D} \frac{V^2}{2g} = 0.0182 \frac{100}{1.33} \frac{(23.3)^2}{2 \times 32.2} = 11.6$$

The specific weight of air may be computed with sufficient accuracy from the perfect gas equation:

$$\frac{W}{V} = \frac{P}{RT} = \frac{14.7 \times 144}{53.3 \times 530} = 0.075$$

lb per cu ft.

If the specific weight of water may be taken at 62.3 lb. per cu ft, the friction loss in inches of water,

$$H = 11.6 \times \frac{0.075}{62.3} \times 12 = 0.167$$

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Discussion

Since Mr. R. D. Madison, Chairman of the Subcommittee, had advised the Laboratory that he would be out of the country on Government service before this paper was finally ready for distribution to the Committee for comment, he was given a rough draft and asked to comment thereon; his comments are given below.

R. D. MADISON, Buffalo, N. Y. (WRITTEN): Professor Wright has presented the Society with a new friction chart which I am sure we can use with confidence as representing the latest. The chart has the same general appearance and for that reason should be familiar to most users of THE GUIDE. However, the position of the lines is rotated and curved to fit the Moody-Rouse data described by the author and in this respect brings the data closer into agreement with rational and acceptable values.

While the chart is made up for round ducts, the point is raised as to how to use it for other conditions, such as conduits of different roughness as well as for shapes other than round. Theoretically the formula now in THE GUIDE for round and rectangular equivalents should be changed to take care of this new data. Since it is based upon the exponential law, it would be necessary to express the data of the friction chart by an exponential equation that most nearly approximates true data. The following formula does this over the body of the chart with an error of 4 or 5 per cent.

$$\Delta p = 2.74 \frac{L}{d^{1.22}} \left(\frac{V}{1000} \right)^{1.90}$$

where

Δp = pressure loss in inches of water.
L = length of duct in feet.
d = diameter of duct in inches.
V = velocity of standard air in feet per minute.

If we assume that the loss in a rectangular duct is:

$$\Delta p_1 = 2.74 \; L \left(\frac{a+b}{2ab} \right)^{1.22} \left(\frac{V_a}{1000} \right)^{1.90}$$

on the basis of the mean hydraulic radius, then equating the friction in two ducts having equal volumes of flow, we have:

$$d = \frac{1.297 \; (ab)^{0.625}}{(a+b)^{0.250}}$$

Rectangular equivalents of round ducts as given by this formula compared with that given in THE GUIDE are very nearly the same for ducts that are square or nearly so. There begins to be a difference where the ratio of a/b is large. However, since the validity of the formula for mean hydraulic radius is under some question for large aspect ratios, there seems to be no need of recalculating THE GUIDE tables until a study is made of this question. The Committee on Duct Friction has this in mind as one of the projects for the Laboratory.

The question of roughness of surface is too complicated to be represented by simple factors. However a plot can be made of factors versus diameter for various velocities. This gives a family of curves that are fairly well separated and should prove useful. I would suggest that these be worked up and placed in THE GUIDE. For example, plots could be made of 1000, 2000, 5000 and 10,000 fpm for each of the classifications listed below.

Perfectly smooth pipe	= 0.000005
New steel pipe	= 0.00015
Galvanized iron	= 0.0005
Average concrete	= 0.003
Average riveted steel	= 0.01

One more point requires attention and that is the correction for density. For ordinary ventilating work, we can vary friction directly as the density without serious error. For temperatures or viscosities much different from standard, it will be safest to go back to the Moody-Rouse data. However, approximations can be made as follows:

For perfectly smooth ducts—

$$H_a = H_s \left(\frac{\rho_a}{\rho_s} \right)^{0.81} \left(\frac{\mu_a}{\mu_s} \right)^{0.19}$$

For average galvanized ducts—

$$H_a = H_s \left(\frac{\rho_a}{\rho_s} \right)^{0.99} \left(\frac{\mu_a}{\mu_s} \right)^{0.1}$$

And for very rough ducts—

$$H_a = H_s \left(\frac{\rho_a}{\rho_s} \right)$$

Where

H = friction loss
ρ = density
μ = viscosity (absolute)

} all in any consistent units

and subscript a refers to actual conditions and subscript s refers to standard conditions.

NOMINATIONS FOR 1946

Nominations for Officers and Council

The Nominating Committee appointed to select candidates for Officers of the Society for the coming year, 1946, submits the following list of nominees:

For President:
ALFRED J. OFFNER, New York, N. Y.

For First Vice-President:
B. M. WOODS, Berkeley, Calif.

For Second Vice-President:
G. L. TUVE, Cleveland, Ohio

For Treasurer:
J. F. COLLINS, JR., Pittsburgh, Pa.

For Members of Council (Three-Year Term)
EARL G. CARRIER, Boston, Mass.
F. W. HUTCHINSON, Lafayette, Ind.
R. A. SHERMAN, Columbus, Ohio
M. S. WUNDERLICH, St. Paul, Minn.

Respectfully submitted,
NOMINATING COMMITTEE,
M. W. BISHOP, *Chairman*

In accordance with the provisions of the Society's Constitution, By-Laws and Rules, ballots containing the names of the above candidates will be sent to the membership for voting upon prior to the Annual Meeting in January.

Art. B-VIII—*Section 11.* The Nominating Committee shall consist of one (1) member eligible to vote designated by each Chapter, or his alternate also appointed by the Chapter. The Secretary of each Chapter shall certify to the Secretary of the Society on or before January first the names of the member and alternate selected.

The Committee shall meet at the Annual Meeting of the Society at the call of the Secretary of the Society and shall effect its own organization and elect its own Chairman. At the Semi-Annual Meeting of the Society, if possible, the Nominating Committee shall select the nominees for the ensuing year for the offices of President, First Vice-President, Second Vice-President, Treasurer, and four (4) members of the Council. In any event the names of the nominees shall be certified to the Secretary of the Society before September twentieth, with the written consent of each nominee to fill the office for which he has been selected and their names with the offices to which they have been nominated shall be published in the October issue of the Journal.

Art. B-IX—*Section 1.* Twenty (20) or more members of the Society, eligible to vote, may present to the Secretary, over their signatures, the name of any member eligible to hold office in the Society as a candidate for any office, provided such name is presented at least sixty (60) days preceding the next Annual Meeting, together with the written consent of the nominee to fill the office for which he has been selected, and the Secretary shall add such names to the ballot if they are not already included in the list of names presented in the formal report of the Nominating Committee. Such names when presented shall be included on the printed ballot, with special notation that they are presented by members independent of the Nominating Committee report. . . .

Art. B-IX—*Section 2.* The Secretary shall prepare ballots with the names of all candidates and forward them to the members, eligible to vote, at least thirty (30) days before the date of the Annual Meeting.

Nominations for Members of Committee on Research

Although committees of the Society are usually appointed, in view of the great importance of the Committee on Research and the financial responsibility it would be called upon to assume, it has been made more representative of the entire membership of the Society by a process of *election.* The election is governed by the By-Laws for the election of officers, with the single exception that Members of the Committee on Research are nominated by the Council instead of by a Nominating Committee.

In accordance with the Regulations for the Government of the Research Laboratory, the Council announces the nomination of the following members of the Committee for election to succeed those members whose present terms expire January, 1946.

Three-Year Term

L. N. HUNTER, Johnstown, Pa.

C. O. MACKEY, Ithaca, N. Y.

R. D. MADISON, Buffalo, N. Y.

L. G. MILLER, East Lansing, Mich.

L. P. SAUNDERS, Lockport, N. Y.

The regulations governing the nomination and election of members of the Committee on Research are as follows:

ARTICLE II—ORGANIZATION

Section 1. Committee on Research—There shall be a standing committee known as the Committee on Research, consisting of fifteen (15) members each serving for three (3) years and five (5) retiring each year. The outgoing Chairman if serving in that capacity during the last year of his three (3) year term on the Committee shall without election become an additional member of the Committee on Research for one (1) year.

(*a*) The Council shall nominate previous to July first of each year five (5) members to fill the vacancies of those retiring at the next Annual Meeting.

(*b*) The nominations made by the Council shall be published in the October issue of the Society's Journal.

(*c*) Any ten (10) members of the Society eligible to vote may present to the Secretary over their signatures, the name of one (1) or more additional nominees for the Committee on Research, provided such name or names are presented at least sixty (60) days prior to the next Annual Meeting, and such additional nominations shall be placed on the ballot opposite the nominations made by the Council.

(*d*) The election shall otherwise conform to the regulations provided for the election of officers of the Society in the Constitution, By-Laws and Rules.

(*e*) Vacancies may be filled by the Council, such persons chosen by the Council to serve until a successor is elected at the next Annual Meeting.

Committee on Research

Seated: **A. C. Fieldner, L. P. Saunders, Dr. C.-E. A. Winslow, Prof. G. L. Tuve, C. M. Ashley.** ***Standing:*** **W. E. Zieber, F. C. McIntosh, J. W. James, Capt. A. E. Stacey, Jr., R. M. Conner, Prof. F. W. Hutchinson, R. K. Thulman**

Three-Day Conference in Cleveland

A SERIES of Committee Meetings and inspection of the Research Laboratory, and the October meeting of the Northern Ohio Chapter provided three days of activity for members of the Committee on Research, Technical Advisory Committees, the Council, and Chapter members from October 6-8.

Over 200 members attended these functions which were concluded with the Northern Ohio Chapter dinner in the Euclid Room of the Hotel Statler, at which the speaker was Dr. C.-E. A. Winslow, New Haven, Conn., president of the Society.

On October 6, a series of Technical Advisory Committee meetings were held at the Research Laboratory, as well as a meeting of the Committee on Research.

On Sunday, October 7, the Council held its Fall meeting at the Hotel Statler, with 13 members present, and by invitation, E. G. Carrier, Boston, Mass.; Prof. F. W. Hutchinson, Lafayette, Ind.; C. S. Leopold, Philadelphia, Pa.; C. F. Roth, New York, N. Y.; Capt. A. E. Stacey, Jr., New York, N. Y., and Cyril Tasker, Cleveland, Ohio. The Budget for the fiscal year, November 1, 1945, to October 31, 1946, was adopted. Needed revisions in the Society's Charter were authorized, and this question is to be voted on by all members present at the 52nd Annual Meeting scheduled for January 28-30, 1946, at Hotel Commodore, New York, N. Y. It was also decided that the Expositions which were suspended during the war period would be resumed on an annual basis, commencing in 1947. Reports from Council Committees and Special Committees were received. It was reported that the membership of the Society had reached the highest point in its history and that the aim of the Membership Committee of having 4500 members in 1945 would be realized.

On Monday, October 8, the Committee on Research held open house at the Laboratory, 10700 Euclid Ave., and an opportunity was afforded to visiting members to see the work in progress and discuss projects with Director Tasker and the staff members.

At noon a group luncheon was enjoyed at the Cleveland Club.

At 2:00 p.m. Pres. Gayle B. Priester of Northern Ohio Chapter called the technical meeting to order in the Pine room of the Hotel Statler and welcomed the visiting members to the Northern Ohio Chapter.

H. G. Dyktor, Chief, Bureau of Industrial Hygiene, Division of Health, City of Cleveland, was introduced and presented his paper, Relation of the Ventilation Engi-

Dinner meeting of Northern Ohio Chapter and friends

neer to Industrial Hygiene (see p. 559).

George V. Parmelee, Research Fellow, at ASHVE Research Laboratory, presented his paper on Transmission of Solar Radiation Through Flat Glass Under Summer Conditions (see p. 562).

D. K. Wright, Jr., Assistant Professor, Case School of Applied Science, presented his paper on A New Friction Chart for Round Ducts (see p. 577).

Following all the papers there was an interesting discussion by the members present.

After the meeting, at 5:30 p.m., there was a Social Hour in the Pine Room, after which the group moved into the Euclid Room for the dinner. Professor Priester, President of Northern Ohio Chapter, welcomed the members and ladies in attendance and turned the meeting over to L. T. Avery, member of Council, who acted as toastmaster. Mr. Avery presented the guests, and following the dinner he introduced Dr. C.-E. A. Winslow, President of ASHVE, who spoke on The Air Cooled Human Body. This subject proved to be of great interest to the members present, and Dr. Winslow answered many questions at the conclusion of his talk.

SUMMARY OF LOCAL CHAPTER MEETINGS

(*See p. 596 for additional reports*)

CONNECTICUT—September 28. Subject: Cast-Iron Boilers and Their Use at Pressures Above 15 lb. Speaker: Stanley K. Smith, President, H. B. Smith Co., Westfield, Mass. Mr. Smith called attention to the outstanding job accomplished by this type of equipment in the past war, and at the conclusion of his talk he introduced Messrs. Harold Riley and Lawrence Seaman, both of Springfield, Mass., who gave an exceptional demonstration of modern selling. Julius Smak reported in the absence of the Finance Committee Chairman, T. S. Hart. S. R. Osborne, chairman of the Meetings Committee, announced that at least five additional meetings were to be held this season. The resignation of Vice-Pres. L. E. Seeley was announced. He has been made Dean of the College of Technology, University of New Hampshire, Durham, N. H. Attendance, 78. Attendance ratio, 1.1.

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GOLDEN GATE—September 14. Subject: Has the ASHVE a Future? Speaker: Dr. B. M. Woods, chairman of Finance Committee and member of Council of Society, and Director of University Extension, University of California, Berkeley, Calif. Dr. Woods described the sound financial condition of the Society and stated that it celebrated its Fiftieth Anniversary last year. He told of the Research Laboratory at Cleveland, operated by the Society, and summed up by saying that on the basis of its financial condition, the high rating of the Research Laboratory and its value to industry, its increasing membership, he is convinced that the Society will have a great future. President Holland told of his efforts to strengthen the relationship between the Pacific Coast Chapters in order that this section, which is so remote from the National Headquarters, may make themselves felt at the Annual and Semi-Annual Meetings. He then asked for suggestions toward this objective from the members. Attendance, 44. Attendance ratio, 0.53.

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INDIANA—October 1. Subject: Development of Atomic Energy. Speaker: Robert Kryter, Sales Mgr. and Engr., Esterline-Angus Co., and past president of Indiana Chemergic Society. The Special Nominating Committee appointed to name a new candidate for the vacancy in the vice-presidency, made its report and an-

Note. The attendance ratios shown above represent the meeting attendance divided by the chapter membership. These ratios will be useful as a partial indication of interest shown by local chapter members in various types of subjects programmed by the various chapters and may be useful in deciding on subjects for chapter meetings.

52nd ANNUAL MEETING ANNOUNCED

The 52nd Annual Meeting of the Society will be held January 28-30, 1946, in New York, with headquarters at the Hotel Commodore, and arrangements will be in charge of New York Chapter.

The Council accepted the invitation of New York Chapter to be hosts for this meeting, and H. J. Ryan, president of the Chapter, has announced the appointment of R. H. Carpenter as General Chairman of the Committee on Arrangements.

The Program Committee reported at the October Council meeting and it was decided to hold a business session on Monday, January 28, devoted to reports of officers, consideration of amendments to the Society's Charter, and recommendations for amendments to the Constitution and By-Laws. Technical sessions are scheduled for Tuesday and Wednesday, and it is planned to hold the Annual Banquet on Tuesday evening, January 29.

Preceding the meeting there will be meetings of the Council, Committee on Research, Technical Advisory Committees, and other Special Committees. Program details will be published in the next issue.

nounced the nomination of C. R. Ammerman to fill the office as Vice-President. Attendance, 61. Attendance ratio, 0.77.

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KANSAS CITY—October 1. Subject: Heating and Air Conditioning Design and Construction Practice in Latin America. Speaker: Alfred J. Offner, First Vice-President of ASHVE, and Consulting Engr., New York, N. Y. The first part of Mr. Offner's talk covered the Latin American countries generally, including their natural resources, customs, geography, climate, etc. The second part was devoted to a more complete description of the general heating and air conditioning practices in all of the various countries. An interesting discussion followed Mr. Offner's talk, which was well received, as it gave a very interesting picture of Latin America and the heating and air conditioning business there. A short movie on The Bell Helicopter was shown. Attendance, 48.

MEMPHIS—October 8. Subject: Drying of Lumber in a Cooperage Plant. Speaker: W. L. Wellford, Jr., Memphis. Pres. T. J. O'Brien announced the election of Ralph Hughes, W. E. Thorpe and W. A. Danielson as members of the Board of Governors. President O'Brien also announced that all future meetings of the Memphis Chapter would be held on the first Monday of each month. Attendance, 26. Attendance ratio, 0.87.

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MINNESOTA—September 11. Subject: Panel Heating Research. Speaker: F. W. Hutchinson, Professor of Mechanical Engineering, Purdue University, Lafayette, Ind. Professor Hutchinson stressed the nature of true radiant heating and the results obtained in a number of tests especially from the physiological standpoint. M. S. Wunderlich submitted his report as chairman of the Auditing Committee. John Haines announced the program for the coming season. Attendance, 85.

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NORTH TEXAS—September 17. Subject: Atomic Energy. Speaker: G. E. Kidd. Mr. Kidd's talk was one of the most interesting, and the interest of the members was evidenced by the fact that the meeting did not adjourn until 10:15. J. P. Ashcraft, chairman of the Program Committee, reported on the programs for the balance of the year. Attendance, 49. Attendance ratio, 0.93.

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ST. LOUIS—September 11. Subject: The New St. Louis Code on Air Conditioning. Speaker: M. Austin True, Supt. of Mechanical Equipment, Building Division, City of St. Louis. Mr. True explained that the new St. Louis Building Code included for the first time codes on air conditioning and ventilation. He also explained that this code was similar to codes in use in most of the larger cities of the United States, and after explaining the high lights of the Code as affecting air conditioning and ventilation, Mr. True offered to answer any questions. It was the consensus of opinion that the Code required rather expensive and elaborate installations, both as to amount of fresh air required and total air handled. Mr. True further explained that these provisions were all made in the interest of safety and better work, and that while they might seem rather severe at first, he felt that a liberal interpretation of the code would be in order for some time, and that cooperation with the industry in St. Louis was essential. Attendance, 61.

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WISCONSIN—September 17. Subject: The Principle of the Gas Turbine. Speaker: W. B. Tucker, Mgr., Aircraft Section, Steam Turbine Department, Allis-Chalmers Mfg. Co., Milwaukee, Wis. Mr. Tucker first touched upon the history of the gas turbine from 130 B.C. to date, and then discussed the advantages of gas turbine units. He pointed out the relatively low cost of fuel which may be employed in units of this type. An interesting discussion followed, and a rising vote of thanks was given Mr. Tucker. Attendance, 62. Attendance ratio, 0.82.

RADIANT BASEBOARD HEATING

The Engineering Experiment Station of the University of Illinois has issued a report of tests on radiant baseboards installed along outside walls in the I-B-R Research Home (*Bulletin Series No. 358*). The tests were conducted during the 1943-44 and 1944-45 heating seasons. Systems used were of both the one-pipe forced circulation and the two-pipe gravity type.

The following results and conclusions are taken from the abstract in the Bulletin:

"At an outdoor temperature of zero deg F and an indoor temperature of 72 deg F at the 30-in. level, when the rooms were heated by the radiant baseboards, the average floor to ceiling temperature difference was only about 2 deg F as compared with 5½ deg F obtained when the rooms were heated by conventional recessed radiators. The average temperature obtained 3 in. above the floor with the radiant baseboards was about 1.4 deg F higher than that obtained with conventional recessed radiators, and the use of a radiant baseboard in the lavatory, which had a concrete floor laid directly on the ground, raised this temperature 6 deg F. A cold floor is a major factor in contributing to discomfort in otherwise well-heated rooms, hence, the tendency to produce a warm floor may be regarded as an important attribute of radiant baseboards. This attribute is most important in the case of the basementless house in which cold floors are particularly prevalent. Therefore, the use of radiant baseboards is especially adaptable to this type of construction.

"The temperature of the entire wall below the 60-in. level was higher than that of the room air at the 30-in. level when radiant baseboards were used, whereas with the conventional recessed radiators the temperature of this portion of the wall surface was from 0.2 to 1.6 deg F lower than the temperature of the air at the 30-in. level.

"When operating with reduced air temperatures at night, the performance obtained with radiant baseboards was, in general, the same as that obtained with the conventional recessed radiators. However, in the case of the radiant baseboards, the over-runs in the temperature of the air 3 in. below the ceiling during the warming-up period were somewhat less than those obtained with the conventional recessed radiators.

"No material difference in fuel consumption could be attributed to the inherent characteristics of the radiant baseboards."

LIBRARY BOOKS ACKNOWLEDGED

Since the announcement of the establishment of the John R. Allen Memorial Library at the ASHVE Research Laboratory in Cleveland, Ohio, the Director of Research, Cyril Tasker, reports a growing list of contributions from members and friends.

It is the desire of the Committee on Research to acknowledge with thanks the accompanying list of books which have been received recently for the Library.

The establishment of the John R. Allen Memorial Library is to honor the pioneer work of one of the Society's past presidents and the first director of its Research Laboratory.

Members of the Society who have books, pamphlets and other printed material dealing with the arts and sciences of heating, ventilating, air conditioning are invited to contribute such matter. A special bookplate will be placed in each volume and all contributed volumes will bear the name of the donor. Contributions should be sent by parcel post or express collect to the Director, ASHVE Research Laboratory, 10700 Euclid Ave., Cleveland 6, Ohio.

TITLE	AUTHOR	DONOR
Water and Air Circulation in Heating and Ventilating		G. A. Dornheim
Fifty Years of New York Steam Service		G. A. Dornheim
The Design of Fans	Frank H. Slade	J. B. Pinkerton
The Design of Pumps	Frank H. Slade	J. B. Pinkerton
The Design of Sheet Metal Air Ducts	F. C. Smith	J. B. Pinkerton
Electricity Simply Explained	H. M. Winstanley	J. B. Pinkerton
Central Station Heating	Byron T. Gifford	A. C. Willard
Power Heating and Ventilation	Charles L. Hubbard	A. C. Willard
Steam Air and Gas Power	William H. Severns Howard E. Degler	A. C. Willard
Mechanical Equipment of Buildings Vol. I Heating and Ventilation	Louis A. Harding Arthur C. Willard	A. C. Willard
Mechanical Equipment of Buildings Vol. II Power Plants and Refrigeration	Louis A. Harding Arthur C. Willard	A. C. Willard
Ventilation and Heating—Principles and Application		A. C. Willard
Helios		A. C. Willard
Design of Industrial Exhaust Systems	John L. Alden	A. C. Willard
Engineering Thermodynamics	James A. Moyer James P. Calderwood	A. C. Willard
Mechanical Equipment of Federal Buildings Second Revised Edition	Nelson S. Thompson	A. C. Willard
Mechanical Equipment of Federal Buildings Third Revised Edition	Nelson S. Thompson	A. C. Willard
Mechanical Draft		A. C. Willard
Heating and Ventilation		A. C. Willard
Elements of Heating and Ventilation	Arthur M. Greene, Jr.	A. C. Willard
House Design Construction and Equipment		A. C. Willard
Steam Boilers—Their Theory and Design	H. deB. Parsons	A. C. Willard
Extension Division, The University of Wisconsin—Steam Boilers		A. C. Willard
American Society of Heating and Ventilating Engineers' Codes		A. C. Willard
Designing Heating and Ventilating Systems	Charles A. Fuller	A. C. Willard
Gravity Warm Air Heating		A. C. Willard
Heating and Ventilation	C. W. Brabbée	A. C. Willard
Air Conditioning Analysis with Psychrometric Charts and Tables	William Goodman	A. C. Willard
Elementary Steam Power Engineering	Edgar MacNaughton	A. C. Willard
Steam Power Plant Engineering	G. F. Gebhardt	A. C. Willard
Experimental Engineering and Manual for Testing	Rolla C. Carpenter Herman Diedericks	A. C. Willard
Heating and Ventilating Buildings	Rolla C. Carpenter	A. C. Willard
Practical Steam and Hot Water Heating and Ventilation	Alfred G. King	A. C. Willard

Handbook of the Petroleum Industry	S. S. Amdursky	A. C. Willard
Air Conditioning for Comfort	Samuel R. Lewis	Keeney Publishing Co.
Forced Air Heating	Platte Overton	Keeney Publishing Co.
Correct Practice in Heating Large Buildings		Keeney Publishing Co.
Corrosion in Steam Heating Systems	Leo F. Collins Everette L. Henderson	Keeney Publishing Co.
Correct Practice in Industrial Sheet Metal Work		Keeney Publishing Co.
Radiant Heating and Cooling		Keeney Publishing Co.
Pattern Development for Air Conditioning Fittings	William Neubecker	Keeney Publishing Co.
Practical Standards for Air Conditioning Calculations	W. S. Bodinus	Keeney Publishing Co.
Duct Work Estimating Tables	E. B. Root	Keeney Publishing Co.
Correct Practice in Industrial Piping Maintenance		Keeney Publishing Co.

J. C. Fitts

N. J. AMERICAN LEGION ELECTS FITTS COMMANDER

At the 27th Annual Convention of the American Legion, Department of New Jersey, held in Atlantic City, N. J., October 13, 1945, J. C. Fitts was elected commander. Mr. Fitts is well known as secretary of the *Heating, Piping and Air Conditioning Contractors National Association,* and a member of the Publication Committee of the ASHVE, and chairman of the Technical Advisory Committee on Radiation and Comfort.

Mr. Fitts served in the U. S. Army during World War I, from 1916 to 1919. He was commissioned a first lieutenant in the infantry, and in the corps of engineers, and on November 1, 1918, he received his advancement to captain in the corps of engineers.

In 1919 he became secretary of the Committee on Standards, secretary of Committee on Certified Heating, secretary of Committee on Trade Promotion, and associate editor of the *Official Bulletin* of the *Heating, Piping and Air Conditioning Contractors National Association.*

After 11 years on the *HPACCNA* staff, Mr. Fitts was elected secretary of the Association at its June meeting in 1930.

He was born at Washington, N. J., on October 10, 1890, and after graduating from Washington High School he attended the Centenary Collegiate Institute. He received his A.B. (Magna Cum Laude) from Princeton in 1912.

DR. GIESECKE RETIRES FROM A. & M.

After 59 years of service to education, Dr. F. E. Giesecke, affectionately known as "Pal" in the class of '86, has resigned from the staff of the A. & M. College of Texas, College Station.

Dr. Giesecke, who was president of the Society in 1940, and one of the nation's outstanding authorities on heating and ventilating, will devote part of his time to professional work as a consultant in that field.

In 1942 he was awarded the F. Paul Anderson Gold Medal by the ASHVE for distinguished scientific achievement.

Dr. and Mrs. Giesecke will make their home at New Braunfels, living in the old Giesecke homestead.

SZEKELY ELECTED VICE-PRESIDENT OF ESM

Ernest Szekely, Milwaukee, Wis., was elected vice-president of the *Engineers' Society of Milwaukee* at a meeting on October 17. Mr. Szekely, a member of the Society's Council, is president of the Bayley Blower Co. He was born July 24, 1888, and received degrees in mechanical and electrical engineering at the University of Budapest, where he was later an associate professor. For a number of years he was on the engineering staff of American Blower Corp., Detroit, Mich., and later he organized his own consulting firm in Cleveland.

Mr. Szekely has been director and president of both the Northern Ohio and Wisconsin Chapters of the Society, and has served on many local and national advisory committees of the Society. He is also a member of the *ASME, Wisconsin Society of Professional Engineers,* Tau Beta Pi, Pi Tau Sigma, faculty of Marquette University, Rotary Club, trustee of B. V. E. V. Reformed Church, director of Town Hall of Milwaukee, and a member of the Astronomical Society.

Candidates for Membership

The Constitution of the Society, as now amended, requires the following mode of procedure in voting on applicants for membership in the Society. All applications for membership are to be sent to the Secretary and the names of applicants and their references shall be printed in the next issue of the Journal of the Society or sent to the members in other approved manner as ordered by the Council. When replies are received from references, the Candidate's application shall be submitted to and acted upon by the Committee on Admission and Advancement as soon as possible.

When the Committee on Admission and Advancement has acted favorably upon a Candidate's application and assigned his grade, the Council shall vote upon the election of the proposed Candidate for membership by letter ballot.

During the past two months, 75 applications for membership have been received and the names of these men and their sponsors are published in the following list.

Members are requested to scrutinize the list with care. The Committee on Admission and Advancement, and in turn, the Council, urge members to assume their share of responsibility of receiving these candidates into membership by advising the Secretary promptly of any whose eligibility for membership is in any way questioned.

All correspondence in regard to such matters is strictly confidential, and is solely for the good of the Society, which it is the duty of every member to promote.

Unless objection is made by some member by November 30, 1945, these candidates will be balloted upon by the Council. Those elected to membership will be notified by the Secretary immediately after election.

ADAMS, THOMAS K., Dept. Mgr., Reunert & Lenz, Ltd. PROPOSERS: R. S. Caldwell, Jacob Ehlers. SECONDERS: C. A. Christierson, S. H. Overton.

ALLISON, JOHN H., Sales Engr., E. J. Deckman Co. PROPOSERS: P. A. Edwards, T. F. Campbell. SECONDERS: H. E. Park, E. C. Smyers.

ATHERTON, RUSSELL C., Engr., M. J. Daly & Sons. PROPOSERS: P. D. Bemis, L. O. R. Clark. SECONDERS: Winfield Roeder, W. A. Johnson.

BAAN, GEORGE B., Mgr., Hat Corporation of America. PROPOSERS: Thomas Blagden*, G. F. Eveleth*. SECONDERS: Victor Civkin*, Stephen Amann*.

BABCOCK, DAN, Plant Engr., Allison Div., General Motors Corp. PROPOSERS: G. B. Supple, R. D. Tutt. SECONDERS: R. C. Blackman, W. E. Goohs.

BAHLER, ROBERT E., Asst. Engr., U. S. Army Engineers. PROPOSERS: C. D. Berkeley, O. W. Priebe. SECONDERS: E. J. Rosen, G. H. Isley.

BANKSTON, CLAYTON V., Dist. Repr., Higgins Industries, Inc. PROPOSERS: R. V. Busenlener, R. B. Guest. SECONDERS: J. S. Burke, J. O. Crary.

BARMANN, PAUL V., Pres., Lydick-Barmann Co. PROPOSERS: E. T. Gessell, Oslin Nation. SECONDERS: R. E. Allison, H. L. Jones.

BEGOON, GEORGE F., Mgr., Precipitron Dept., Westinghouse Electric Corp. PROPOSERS: J. C. Fitz, I. R. Cummings. SECONDERS: E. H. R. Pegg, J. J. Tillotson.

BOYER, CHARLES T., Engr., Servel, Inc. PROPOSERS: N. E. Berry, H. C. Pierce. SECONDERS: J. K. Knighton, F. A. Grossman.

BRENTON, REGINALD S., Partner, Brenton & Hart. PROPOSERS: T. S. Hart, Stanley Hart. SECONDERS: J. H. Smart, Leonard Zavorski.

BURKLE, LOUIS W., Installation Service Mgr., J. E. Daly Co. PROPOSERS: C. L. L'Hommedieu, L. E. Seeley. SECONDERS: D. M. Hummel, L. A. Teasdale.

DASTUR, MANECK N., Jr. Engr., Carrier Corp. PROPOSERS: W. G. Hillen, C. M. Ashley. SECONDERS: J. H. Carpenter, D. D. Wile.

DAVIS, ROBERT H., Sales Engr., Johnson Service Co. PROPOSERS: H. W. Alyea, J. R. Vernon. SECONDERS: H. W. Schreiber, M. W. Bishop.

DEAN, EDWIN C., Mech. Engr., 8th Service Command. PROPOSERS: W. A. Catlett, P. H. Schuster. SECONDERS: J. P. Ashcraft, B. S. Foss, Jr.

DELALANDE, ANDRE, Cons. Engr. PROPOSERS: J. E. Cusset*, G. Leduc.* SECONDERS: R. Duminy, R. Masse.*

DOME, ALAN G., Naval Archt., United States Maritime Commission. (*Advancement*). PROPOSERS: M. F. Blankin, N. S. MacFarlan. SECONDERS: Edwin Elliot, H. T. Makin, Jr.

ELLIOTT, JAMES H., Engr., Army Air Forces. PROPOSERS: H. E. Sproull, M. E. Mathewson. SECONDERS: W. H. Junker, G. B. Houliston.

FARNBACHER, JOHN M., Student Engr., Chrysler Corp. PROPOSERS: F. H. Pasiadis, J. R. McCallum*. SECONDERS: C. R. Neeson*, A. R. Weber*.

FREITES, ANDRES A., Jr. Engr., Carrier Corp. PROPOSERS: W. G. Hillen, C. M. Ashley. SECONDERS: J. H. Carpenter, D. D. Wile.

GARVIN, JOSHUA L., Operations Engr., Charleston Army Air Field. PROPOSERS: C. G. Hartsfield, F. A. Bailey, Jr. SECONDERS: J. O. Sanders, Jr.*, S. C. Councill*.

GLOVER, RALPH P., Cons. Engr. PROPOSERS: Ernest Szekely, B. M. Kluge. SECONDERS: M. W. Bishop, J. P. Vernon.

GODFREY, THEODORE R., Partner, F. H. Godfrey Engineering Co. PROPOSERS: C. W. May, E. H. Langdon. SECONDERS: R. O. Wesley, S. D. Peterson.

GRISWOLD, ARTHUR S., Engr., The Detroit Edison Co. PROPOSERS: G. D. Winans, C. F. Donohoe. SECONDERS: E. T. Smith, E. E. Dubry.

HAMER, FRED S., Design Engr., Surface Combustion Corp. PROPOSERS: W. M. Myler, Jr., J. I. Trimble. SECONDERS: A. W. Williams, H. R. Allonier.

HARRISON, PAUL N., Owner, Paul N. Harrison Co. PROPOSERS: R. C. Cushing, C. L. Peterson. SECONDERS: N. H. Peterson, H. V. Hickman.

HOVDA, ARTHUR F., Htg. Inspector, City of Minneapolis. PROPOSERS: H. M. Betts, F. W. Legler. SECONDERS: Harry Quade, Jr., J. C. Davidson.

INGLE, JOHN F., Sr., Field Engr., Sterling Electric Motors, Inc. PROPOSERS: W. D. Fabling, Leo Hungerford. SECONDERS: R. A. Lowe, A. G. Orear.

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Candidates Elected

In the past issues of the Journal of the Society the names of the following men were listed as Candidates for Membership. The membership grade of each Candidate has been assigned by the Committee on Admission and Advancement and balloted upon by the Council. We are now instructed by the Council to post herewith, as required by Art. B-III, Sec. 8, of the By-Laws, the following list of candidates elected:

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ATKINS, THOMAS J., Philadelphia, Pa. (Reinstatement).

BAUER, RAY F., Engr., J. M. O'Connor Co., Wichita, Kans.

BAUTTS, RAY A., Local Mgr., Arkansas Power & Light Co., Jonesboro, Ark.

BLADEN, ARTHUR M., Owner, Neiler, Rich & Bladen, Chicago, Ill.

BOWIE, ROBERT, Mgr., Engrg. Dept., H. G. Skelton & Co., Capetown, South Africa.

BURTON, CHARLES C., Mech. Engr., Johns-Manville International Corp., New York, N. Y.

CAMPBELL, ROBERT E., Major, C. E., Silver Spring, Md. (*Reinstatement*).

CHADWICK, GEORGE R., Wright Field, Dayton, Ohio.

CLARK, ALLAN M., Joint Mgr., Canadian Blower & Forge Co., Ltd., Toronto, Ont., Canada. (*Advancement*).

DEUBEL, JUSTIN A., Devlpt. Engr., Perfex Corp., Milwaukee, Wis.

FAY, SAMUEL C., Engr., The Eagle Picher Sales Co., Cincinnati, Ohio.

GSCHWIND, JEAN F., Devlpt. Engr., J. O. Ross Engineering Corp., New York, N. Y.

HENZE, ARTHUR L., Mech. Engr., Walter Scholer, Lafayette, Ind.

HENZEL, JOHN H., Mech. Engr., Arthur G. McKee & Co., Cleveland, Ohio.

HERKIMER, HERBERT, Cost Appraiser, War Shipping Administration, New York, N. Y. (*Reinstatement*).

HERRICK, MARVIN M., Appl. Engr., Johnson Service Co., Milwaukee, Wis.

HICKMAN, HERBERT V., Gen. Mgr., Neil H. Peterson Co., San Francisco, Calif. (Advancement)

ISKYAN, HAIG S., Research Engr., Curtiss Wright Corp., Buffalo, N. Y.

JANSSEN, FRED, Engr., Public Service Company of Colorado, Denver, Colo. (*Advancement*).

KELLY, HERBERT C., Pres., The George-Howard Co., New Haven, Conn.

KINDLER, SIDNEY, Gen. Mgr., Matthew Hall Co., Ltd., London, England.

KING, ROY L., Div. Engr., The Heil Co., Milwaukee, Wis. (*Advancement*).

MALONE, JOHN F., Asst. Mgr., Consolidated Gas, Electric Light & Power Co., Baltimore, Md.

PETERSON, HOWARD H., Cons. Engr., Yakima, Wash.

RASTRICK, RONALD J., Supt. Engr., Vale & Co., Ltd., Christchurch, New Zealand.

SANTTI, KARL E., Mech. Engr., U. S. Navy Yard, Pearl Harbor, Hawaii.

SHERMAN, ROBERT E., Sales Engr., Buffalo Forge Co., Buffalo, N. Y.

SMITH, ELWYN L., Unit Head, Corps of Engineers, War Department, Kansas City, Mo. (*Advancement*).

STRAUCH, PAUL C., Sales Engr., Sears-Piou & Co., St. Louis, Mo. (*Advancement*).

TURNBULL, FRANCIS J., Staff Member, Massachusetts Institute of Technology, Cambridge, Mass.

VERAZA, U. CARLOS, Mgr., Madrigal y Veraza S. de R. L., Mexico, D. F.

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2. **Air Conditioning in Industry:** W. L. Fleisher, *Chairman;* L. T. Avery, Capt. A. R. Behnke, Leonard Greenburg, M.D., W. E. Heibel, D. E. Humphrey, Prof. F. W. Hutchinson,* E. F. Hyde, L. L. Lewis, O. W. Ott, R. R. Sayers, M.D., H. E. Zisl.

3. **Air Distribution and Air Friction:** Ernest Szekely, *Chairman;* S. H. Downs, S. L. Elmer, Jr., K. H. Flint, W. H. Hoppmann II, F. J. Kurth, J. N. Livermore, D. J. Luty, R. D. Madison, Prof. L. G. Miller, Prof. D. W. Nelson, Prof. G. B. Priester, L. P. Saunders.*

4. **Air Sterilization and Odor Control:** Prof. W. F. Wells, *Chairman;* Dr. L. J. Buttolph, Lt. Comdr. W. V. Consolazio, Leonard Greenburg, M.D., Prof. B. H. Jennings, F. H. Munkelt, Dr. G. W. Penney, Prof. J. A. Reyniers, F. W. Robinson, Prof. L. E. Seeley,* Mildred Wells, M.D.

5. **Cooling Load:** W. E. Zieber,* *Chairman;* O. W. Armspach, Prof. H. O. Croft, P. L. Davidson, W. F. Friend, R. H. Heilman, John James,* Prof. C. F. Kayan, J. N. Livermore, Prof. C. O. Mackey, J. P. Stewart.

7. **Corrosion:** L. F. Collins, *Chairman;* R. C. Doremus, Dr. Scott P. Ewing, Dr. E. W. Guernsey, Prof. G. G. Marvin, A. R. Mumford, L. P. Saunders,* F. N. Speller.

9. **Flow of Fluids Through Pipes and Fittings:** Dr. F. E. Giesecke,* *Chairman;* T. M. Dugan, Prof. W. S. Harris, S. R. Lewis, L. P. Saunders.*

10. **Fuels:** R. A. Sherman, *Chairman;* R. M. Conner,* R. S. Dill, R. B. Engdahl, L. N. Hunter, Dr. R. C. Johnson, Prof. S. Konzo, W. M. Myler, Jr., W. T. Reid, Dr. H. J. Rose,* E. T. Selig, Jr., C. E. Shaffer, T. H. Smoot, R. K. Thulman,* E. C. Webb.

11. **Glass:** R. A. Miller, *Chairman;* L. T. Avery, Dr. H. C. Dickinson, J. E. Frazier, E. H. Hobbie, Dr. J. C. Hostetter, L. K. Jones, J. H. Lewis, F. L. Martin, W. C. Randall, Vic Sanders, Prof. L. E. Seeley,* H. B. Vincent, Dr. G. B. Watkins, F. C. Weinert.

12. **Heating Load:** P. D. Close, *Chairman;* C. M. Ashley,* E. K. Campbell, J. F. Collins, Jr., R. C. Cross, Prof. W. S. Harris, H. E. Lewis, M. W. McRae, Prof. T. F. Rockwell, Prof. F. B. Rowley, R. K. Thulman,* G. D. Winans.

13. **Heat Transfer Surfaces:** Prof. William Goodman, *Chairman;* C. L. Bensen, Prof. A. I. Brown, W. E. Heibel, Lieut. A. L. London, J. W. McElgin, R. H. Norris, L. P. Saunders,* C. E. Scott, L. G. Seigel, L. L. Simmons, W. C. Whittlesey.

14. **Instruments:** C. M. Ashley,* *Chairman;* Prof. L. M. K. Boelter, E. L. Broderick, R. S. Dill, R. B. Engdahl, Lt. Col. A. P. Gagge, Dean John A. Goff,* Prof. R. C. Jordan, Prof. G. B. Priester, E. W. Rietz, W. R. Teller.

15. **Insulation:** Comdr. E. R. Queer, *Chairman;* R. E. Backstrom, T. H. Coulter, Prof. F. G. Hechler, H. E. Lewis, H. E. Robinson, T. D. Stafford, Capt. T. H. Urdahl,* Prof. G. B. Wilkes, P. M. Woodworth.

16. **Physiological Reactions:** R. W. Keeton, M.D., *Chairman;* Thomas Bedford, M.D., Capt. A. R. Behnke, Dr. A. C. Burton, E. F. DuBois, M.D., Lt. Col. A. P. Gagge, A. C. Ivy, M.D., F. C. McIntosh,* R. R. Sayers, M.D., Charles Sheard, M.D., Col. A. D. Tuttle.

17. **Psychrometry:** J. H. Walker, *Chairman;* Dr. H. C. Dickinson, Dean John A. Goff,* Prof. William Goodman, Prof. A. P. Kratz, D. M. Little, Prof. C. O. Mackey, W. E. K. Middleton, D. D. Wile.

18. **Radiation and Comfort:** J. C. Fitts, *Chairman;* R. E. Daly, Dr. F. E. Giesecke,* L. N. Hunter, Prof. F. W. Hutchinson,* John James,* Prof. A. P. Kratz, C. S. Leopold, E. M. Mittendorff, L. L. Munier, Dr. G. W. Penney, H. F. Randolph, W. R. Rhoton.

19. **Sensations of Comfort:** Thomas Chester, *Chairman;* R. S. Arnold, Prof. M. K. Fahnestock, G. D. Fife, Lt. Col. W. J. McConnell, F. C. McIntosh,* A. B. Newton, K. E. Robinson, Prof. C. P. Yaglou.

20. **Sorbents:** Lt. Comdr. John Everetts, Jr., *Chairman;* R. E. Cherne, O. D. Colvin, F. C. Dehler, L. S. Epstein, Dean John A. Goff,* C. H. B. Hotchkiss, J. C. Patterson, G. L. Simpson, C. F. Sines.

21. **Sound Control:** R. D. Madison, *Chairman;* C. M. Ashley,* Dr. P. H. Geiger, C. H. Hall, W. W. Kennedy, G. C. Kerr, E. W. McMullen, A. G. Sutcliffe, T. H. Troller, Capt. T. H. Urdahl,* Dr. T. A. Walters.

22. **Weather Design Conditions:** Capt. T. H. Urdahl,* *Chairman;* J. C. Albright, C. E. Bentley, R. E. Biller, H. S. Birkett, J. F. Collins, Jr., Lt. Comdr. John Everetts, Jr., J. P. Fitzsimons, Capt. J. D. Kroeker, Comdr. F. W. Reichelderfer, H. C. S. Thom.

*Member of Committee on Research.

Officers of Local Chapters

Atlanta: Organized, 1937. Headquarters, Atlanta, Ga. Meets, First Monday. President, I. B. Kagey, 611 Bona Allen Bldg., Atlanta 3. Secretary, M. F. DuChateau, Washington St. Viaduct, Atlanta 3.

Central New York: Organized, 1944. Headquarters, Syracuse, N. Y. President, C. M. Ashley, 300 S. Geddes St., Syracuse 1. Secretary, F. E. Hockensmith, 400 N. Midler Ave., Syracuse.

Central Ohio: Organized, 1944. Headquarters, Columbus, Ohio. Meets, Third Monday. President, A. W. Williams, 5 E. Long St., Rm. 808, Columbus 15. Secretary, H. R. Allonier, 101 N. High St. Columbus 15.

Cincinnati: Organized, 1932. Headquarters, Cincinnati, Ohio. Meets, Second Tuesday. President, E. J. Richard, 2137 Reading Rd., Cincinnati 2. Secretary, H. K. Jennings, 1639 Union Trust Bldg., Cincinnati 2.

Connecticut: Organized, 1940. Headquarters, New Haven, Conn. President, Stanley Hart, New Britain. Secretary, Winfield Roeder, 405 Temple St., New Haven.

Delta: Organized, 1939. Headquarters, New Orleans, La. Meets, Second Tuesday. President, W. H. Grant, Jr., 209 Vincent Bldg., New Orleans 12. Secretary, J. S. Burke, 317 Baronne St., New Orleans 9.

Golden Gate: Organized, 1937. Headquarters, San Francisco, Calif. Meets, First Wednesday. President, R. B. Holland, 420 Market St., San Francisco 11. Secretary, F. W. Kolb, 598 Monadnock Bldg., San Francisco 5.

Illinois: Organized, 1906. Headquarters, Chicago, Ill. Meets, Second Monday. President, James S. Locke, 433 E. Erie St., Chicago 11. Secretary, C. M. Burnam, Jr., Room 1605, 6 N. Michigan Ave., Chicago 1.

Indiana: Organized, 1943. Headquarters, Indianapolis, Ind. Meets, Fourth Friday. President, G. B. Supple, Architects and Builders Bldg., Indianapolis. Secretary, T. R. Davis, 1311 N Drexel Ave., Indianapolis 1.

Iowa: Organized, 1940. Headquarters, Des Moines, Ia. Meets, Second Tuesday. President, B. E. Landes, 1603 47th St., Des Moines 10. Secretary, C. A. Wheeler, 511 Fifth Ave., Des Moines.

Kansas City: Organized, 1917. Headquarters, Kansas City, Mo. Meets, First Monday, President, R. B. Mason, 2014 Wyandotte St., Kansas City. Secretary, P. C. Leffel, 316 E. 75th St., Kansas City.

Manitoba: Organized, 1935. Headquarters, Winnipeg, Man. Meets, Third Thursday. President, F. T. Ball, 324 Main St., Winnipeg. Secretary, D. S. Swain, 27 Fawcett Ave., Winnipeg.

Massachusetts: Organized, 1912. Headquarters, Boston, Mass. Meets, Third Tuesday. President, D. M. Archer, 143 Federal St., Boston 10. Secretary, A. Ehrenzeller, 23 Parklawn Rd., Boston 32.

Memphis: Organized, 1944. Headquarters, Memphis, Tenn. Meets, First Monday. President, T. J. O'Brien, 1030 Exchange Bldg., Memphis. Secretary, A. T. Bevil, 1521 Waverly Ave., Memphis 6.

Michigan: Organized, 1916. Headquarters, Detroit, Mich. Meets, First Monday after 10th of month. President, R. F. Connell, 1500 United Artists Bldg., Detroit 31. Secretary, A. E. Knibb, 1002 Maryland Ave., Detroit 30.

Minnesota: Organized, 1918. Headquarters, Minneapolis, Minn. Meets, First Monday. President, R. E. Gorgen, 2120 W. Cedar Lake Blvd. Secretary, O. L. Lilja, 5000 16th Ave. S., Minneapolis 7.

Montreal: Organized, 1936. Headquarters, Montreal, Que. Meets, Third Monday. President, A. B. Madden, 1170 Beaver Hall Sq., Montreal, Que. Secretary, Leo Garneau, Room 832, Dominion Sq. Bldg., Montreal, Que.

Nebraska: Organized, 1940. Headquarters, Omaha, Nebr. Meets, Second Tuesday. President, D. E. McCulley, 814 S. 14th St., Omaha 2. Secretary, D. D. Williams, Rm. 311, Federal Bldg., Omaha.

New York: Organized, 1911. Headquarters, New York, N. Y. Meets, Third Monday. President, H. J. Ryan, 101 Park Ave., New York 17. Secretary, Carl H. Flink, Room 3000, 51 Madison Ave., New York 10.

North Carolina: Organized, 1939. Headquarters, Durham, N. C. Meets, Quarterly. President, K. W. Selden, Jr., 701 Builders Bldg., Charlotte 2. Secretary, E. S. DeWitt, 1211 Commercial Bank Bldg., Charlotte.

North Texas: Organized, 1938. Headquarters, Dallas, Tex. Meets, Third Monday. President, E. T. Gessel, 610 Thomas Bldg., Dallas 1. Secretary, C. Rollins Gardner, 911 Camp St., Dallas 2.

Northern Ohio: Organized, 1916. Headquarters, Cleveland, Ohio. Meets, Second Monday. President, G. B. Priester, 10900 Euclid Ave., Cleveland 6. Secretary, R. L. Byers, 448 Terminal Tower, Cleveland 13.

Oklahoma: Organized, 1935. Headquarters, Oklahoma City, Okla. Meets, Second Monday. President, Earle W. Gray, Third & Harvey Sts., Oklahoma City. Secretary, G. T. Donceel, Oklahoma Natural Gas Co., Oklahoma City.

Ontario: Organized, 1922. Headquarters, Toronto, Ont. Meets, First Monday. President, J. P. Fitzsimons, 4 Mowat Ave., Toronto, Ont. Secretary, H. R. Roth, 57 Bloor St., W., Toronto, Ont.

Oregon: Organized, 1939. Headquarters, Portland, Ore. Meets, Thursday after First Tuesday. President, F. F. Urban, 6726 S. W. Burlingame Ave., Portland. Secretary, E. R. Lokey, 1238 N. W. Glisan St., Portland 9.

Pacific Northwest: Organized 1928. Headquarters, Seattle, Wash. Meets, Second Tuesday, President, D. C. Griffin, 717 Lloyd Bldg., Seattle 1. Secretary, C. W. Finn, 717 Lloyd Bldg., Seattle 1.

Philadelphia: Organized, 1916. Headquarters, Philadelphia, Pa. Meets, Second Thursday. President, R. D. Touton, Ninth & Columbia Ave., Philadelphia. Secretary, F. H. Buzzard, 213 S. Broad St., Philadelphia 7.

Pittsburgh: Organized, 1919. Headquarters, Pittsburgh, Pa. Meets, Second Monday. President, L. S. Maehling, 778 Country Club Dr., Pittsburgh 16. Secretary, E. H. Riesmeyer, Jr., 231-33 Water St., Pittsburgh 22.

Rocky Mountain: Organized, 1944. Headquarters, Denver, Colo. Meets, First Wednesday. President, G. D. Maves, 1550 Glencoe St., Denver 7. Secretary, Fred Janssen, 1123 W. Third Ave., Denver 9.

St. Louis: Organized, 1918. Headquarters, St. Louis, Mo. Meets, First Tuesday. President, W. J. Oonk, 4548 Red Bud Ave., St. Louis 15. Secretary, W. A. Russell, 7918 Kingsbury Blvd., Clayton 5, Mo.

South Texas: Organized, 1938. Headquarters, Houston, Tex. Meets, Third Friday. President, J. A. Walsh, P. O. Box 1773, Houston. Secretary, D. M. Mills, Gray & Crawford, Houston 3.

Southern California: Organized, 1930. Headquarters, Los Angeles, Calif. Meets, Second Wednesday. President, Maron Kennedy, 5051 Santa Fe Ave., Los Angeles 11. Secretary, R. A. Lowe, 3744 Potomac Ave., Los Angeles 16.

Utah: Organized, 1944. Headquarters, Salt Lake City, Utah. Meets, First Wednesday. President, H. G. Richardson, 1433 Harvard Ave., Salt Lake City. Secretary, E. V. Gritton, 2470 S. 15th East St., Salt Lake City.

Washington, D. C.: Organized, 1935. Headquarters, Washington, D. C. Meets, Second Wednesday. President, W. H. Littleford, 616 New York Ave., N. W., Washington. Secretary, Lester Maurer, 1738-33 Place, S. E., Washington 20.

Western Michigan: Organized, 1931. Headquarters, Grand Rapids, Mich. Meets, Second Monday. President, H. J. Metzger, 137 E. Water St., Kalamazoo. Secretary, H. W. Wolters, 820 Staples Ave., N. W., Kalamazoo 54.

Western New York: Organized, 1919, Headquarters, Buffalo, N. Y. Meets, Second Monday. President, F. A. Moesel, 31 Main St., Buffalo 3. Secretary, J. S. Meyer, 38 Crescent Ave., Buffalo 14.

Wisconsin: Organized, 1922. Headquarters, Milwaukee, Wis. Meets, Third Monday. President, O. A. Trostel, Route No. 2, Thienaville. Secretary, J. R. Vernon, 507 E. Michigan St., Milwaukee 2.

Summary of Local Chapter Meetings*

(*See p. 587 for additional reports*)

CENTRAL OHIO—September 17. Subject: The Application of Heaters to Aircraft and the Heating Problems Involved. Speaker: James W. Ashby, Mgr. of Application Engrg., Aircraft Heater Division, Surface Combustion Corp., Columbus, Ohio. Mr. Ashby's talk was informative, interesting and well delivered. Treasurer, Secretary, and chairman of Meetings and Publicity Committee submitted reports. Attendance, 38. Attendance ratio, 0.50.

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DELTA—September 11. Subject: Sea Food Refrigeration. Speaker: J. Lawrence Rummold. Numerous comments and many questions were offered indicating the interest shown. Capt. T. H. Urdahl, USNR, Washington, D. C., was introduced as a surprise visitor. Captain Urdahl commented on the interesting discussion on sea food refrigeration and related his experiences in the refrigeration and air conditioning field. Treas. L. K. Nelson submitted his report. Messrs. Grant and Kerr commented on the enjoyment at the chapter picnic at Ross Guest's home in Mandeville. L. V. Busenlener, chairman of the membership committee, reported on the progress of his committee. Vice-Pres. W. P. Oster reported on the recommendations made to the Society for changes in Chapter By-Laws, stating that all suggested changes were minor. L. V. Cressy discussed the possibility of a new meeting place. Attendance, 18. Attendance ratio, 0.30.

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NORTH TEXAS—August 20. A short film on the Helicopter, provided by Bell Aircraft Corp., was shown, followed by a long Signal Corps film on German atrocities, furnished by courtesy of the Eighth Service Command. B. S. Foss, Jr., chairman of the membership committee, reported on the progress of the committee. Attendance, 40. Attendance ratio, 0.78.

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SOUTHERN CALIFORNIA—September 12. Subject: Proposed Heating and Ventilating Code for the City of Los Angeles. Speakers: Maron Kennedy and Art Theobald, President and Vice-President of Chapter; A. B. Wickes, Head, Heating and Ventilating Div., City of Los Angeles; and A. J. Hess, Engr., English & Lauer, Inc. Messrs. Kennedy and Theobald expressed their viewpoints on the code, which is now being reviewed by the City Attorney. Mr. Wickes stated that the ordinance, if adopted, will prevent wildcat operators from installing heating equipment improperly, and this ordinance has been developed purely for the purpose of a guarantee for the public. Mr. Hess, who was influential in the development of the new ordinance, discussed its various points and cushioned the anticipated criticism. J. S. Earhart reported on the status of legislation licensing mechanical engineers. R. A. Lowe, retiring treasurer, turned over the accounts to R. S. Farr, and submitted his report. Attendance, 79. Attendance ratio, 0.79.

*Note. The attendance ratios shown above represent the meeting attendance divided by the chapter membership. These ratios will be useful as a partial indication of interest shown by local chapter members in various types of subjects programmed by the various chapters and may be useful in deciding on subjects for chapter meetings.

NEW BOOKS & REPORTS

Opportunities for War Veterans in Air Conditioning and Refrigeration

Published in behalf of America's returning servicemen, the 12 p. pamphlet, Job Opportunities for the War Veteran in the Air Conditioning and Refrigeration Industry, should prove to be both interesting and helpful to those seeking new civilian jobs. It is brief and concise; yet it contains much useful information and will answer some of the questions uppermost in the minds of returning servicemen, together with others, who are thinking of their future in terms of refrigeration and air conditioning.

It is granted that this business of getting squared away again in civilian life is not easy and that there will be an unsettled period during which the veteran will have to forget many things he learned in the service and relearn some of the old and familiar civilian angles —and some new ones developed since he went away. It is also pointed out that the government is going all out to see that the veterans get every break possible; while the people at home will help in every way they can. However, this booklet stresses the fundamental and inescapable fact that in this highly competitive world it is up to the individual to make his own place and his own way. It is up to the individual to decide where and how he will make a living—and up to his energy and intestinal fortitude as to how well he will succeed.

By way of introducing the subject of refrigeration and air conditioning to the reader, some of the many familiar military uses are cited. It is also pointed out that most persons think of refrigeration in terms of the household box, the drinking fountain, a butcher's meat storage box, an ice cream cabinet at the corner drug store, or refrigerated display cases. Similarly the term "air conditioning" generally brings to mind comfort cooling such as is found in theaters, stores, trains, restaurants, etc. Not so obvious to the average person is the great importance of refrigeration and air conditioning to the industrial field. Ice making plants, cold storage warehouses, the manufacture of oil and high test gasoline, the making of synthetic rubber, the transportation of perishable foods, and the manufacture and storage of drugs and medicines are but a few of the vitally important uses of refrigeration in industry. Air conditioning is often essential to the making of rayon, nylon, and other synthetic textiles; to the weaving of woolen, cotton and other fabrics; and it is used in the manufacture and assembly of precision instruments, electrical and telephone equipment, and an infinite number of chemical products.

In order that a person not familiar with the industry may obtain some idea as to the type of work and personnel which are to be found in this field, the pamphlet includes a chart and brief discussion of job opportunities. A breakdown has been made to indicate the types of jobs in office work, production, engineering, distribution, sales, installation, and service. The discussion on engineering is subdivided to include design, test, application, and sales engineers. The brief remarks concerning sales differentiate between manufacturers, jobbers, and dealers and distributors sales.

In regard to training courses it is pointed out that book learning in itself will rarely qualify one for a particular job. What counts is the putting of book learning to use in actual work. Many manufacturers and distributors have their own training courses for employees. In addition there are many trade and vocational schools, and some correspondence schools which offer practical courses in refrigeration and air conditioning and the skills needed therein. However, a warning is given against enrolling in some school or course which is but a gyp or racket. The reader is urged to check with a Veterans Bureau representative or to consult with someone in a position to advise before enrolling. As a further help, almost 200 trade and technical schools, universities, and colleges are listed. This partial list of schools represents 48 states and the District of Columbia and was obtained through the courtesy of the ASRE.

A word of caution in regard to going into business for one's self, together with a short list of recommended texts and trade publications, conclude this pamphlet, which is published by the Air Conditioning and Refrigerating Machinery Association, Inc., Southern Bldg., Washington, D. C. Distribution of the booklet is being made through rehabilitation and separation centers, Army and Navy hospitals, Red Cross, American Legion, Veterans of Foreign Wars, other civic organizations coming in contact with ex-service men, and ACRMA member-companies and their sales outlets.

New Detroit Refrigeration Code

A new refrigeration code for the city of Detroit became effective on September 27, 1945. This code, which supersedes an ordinance originally enacted in 1916, is based upon the American Standards Association refrigeration code and is said to contain inclusions from other sources where established practices have proved their merit. According to the foreword it was "developed in recognition of the need for an instrument which would legally regulate the usage of modern refrigeration systems and equipment in their application to human needs. It was promulgated with the object in view to provide for the greatest latitude in the promotion of health, comfort, and convenience in this field, and at the same time establish construction and operational requirements whereby the desirable ultimate might be approached without jeopardizing the health and safety."

This official code, which constitutes ordinance No. 37-E of the city, and which is divided into 15 sections, defines and classifies refrigerants, refrigeration systems, and various types of buildings on an occupancy basis. In addition, it defines, describes, and limits requirements for the design, installation, and repair of those systems in the various types of buildings. Limitations in regard to the proximity of hot surfaces (about 800 F) and open flames are clearly set forth and ventilation and construction requirements for refrigerating machinery rooms as well as the requirements for pipe fittings, materials, valve locations, testing, and instruction cards are included.

Test pressures for the high side of piping systems

are, in general, required to be equal to the saturated vapor pressure of the refrigerant at 150 F. For "Freon-12" a test pressure of 235 psi is specified for all refrigerant-containing parts on the high side except compressors or unit assemblies, safety devices, pressure gages, and control mechanisms that are factory tested. Inasmuch as some compressors, expansion valves, gages, etc., will not withstand this pressure, it would seem that some differences of opinion may arise between the contractor and the inspector as to where parts of systems may be valved off.

This ordinance, which is applicable to all new refrigeration systems and parts of present systems which are repaired, replaced, or modified, requires that a contractor's license be obtained from the city. The technical requirements for obtaining a license are explained in the first section of the code. In addition to satisfying the board of examiners as to the applicant's qualifications, a fee and the posting of a $1000 bond are required.

The code is issued by the Department of Buildings and Safety Engineering, Detroit, Mich., is printed in pamphlet form, and contains 44 pp., 5½ x 8½ in. The price is 25c.

Ball and Roller Bearings

Dr. Arvid Palmgren, a specialist for almost 30 years in research and engineering of ball and roller bearings, is the 1938 winner of the gold medal of the Engineering Science Academy of Sweden for his work on fatigue phenomena in these types of bearings. His position with SKF in Sweden, in charge of engineering and mechanical research, enables him to speak authoritatively, which he does in his new book, Ball and Roller Bearing Engineering.

Beginning with a technical description of common bearing types, the book continues through nine chapters of fundamental engineering studies. Both radial and thrust bearings are discussed in the first chapter with data on dimensional proportions, running accuracy, and tolerances of each type. The second chapter is devoted to forces and motions in bearings and includes theory and calculations on rolling resistance, friction torque, friction coefficients, stresses and deformations, load distribution, and motion and inertia. Other chapters deal with carrying capacity of ball and roller bearings, bearing selection, design of bearing applications, mounting and dismounting, lubrication and maintenance, and bearing failures.

In his foreword the author states, "Standardization of bearings has made possible the assignment of their design and manufacture to specialists. Thus, the machine designer is not required to include in his efforts the working out of fundamental bearing problems. However, in order to utilize the properties of bearings to the best advantage, machine designers must not only be well acquainted with applied bearing engineering as used in their particular fields, but must also have a knowledge of the bearing elements themselves."

This book, then, is written for those engaged in industry and machine design who wish a better knowledge of the fundamentals of the design, selection, and use of ball and roller bearings. It is not a handbook or a bearing catalog and, on the other hand, it is not an all inclusive text, for topics such as the selection and properties of materials have been omitted. In addition, the examples of bearing application given are typical representative designs without any pretense of covering the entire field. For purposes of simplification, derivations and calculations requiring higher mathematics have been omitted wherever possible.

It is expected that some confusion and lack of a basis for ready comparison of values will occur in the minds of many readers due to the fact that all figures and tabulated data are given in the metric system. Inasmuch as conversion tables are included, this should not deter anyone seriously interested in fundamentals of ball and roller bearings. This volume contains 270 pp. together with 900 odd drawings and tables. First copies of the book will be sent by SKF Industries Inc., Front St. & Erie Ave., Philadelphia 34, Pa. "to the heads of leading corporations, technical schools, colleges, and libraries in principal U.S. cities." Later editions will be sold at cost to students and others interested in bearing studies.

Process Equipment Design

With increasing frequency, practicing engineers encounter problems involving equipment that must serve a special purpose, and suited to the conditions imposed by high temperature, high pressure, handling of corrosive or abrasive liquids, or any combination of these factors. The engineer's task may be the design of such equipment, or the evaluation and selection of equipment offered by manufacturers. To assist in either, a new book—Process Equipment Design, by Herman C. Hesse, professor of engineering drawing and design, and J. Henry Rushton, professor of chemical engineering at the University of Virginia—reviews the fundamentals upon which are based the design and construction of such process equipment.

To use the authors' summary, the book presents the fundamentals of mechanics, machine and structural elements, and economic and manufacturing considerations related to the design of process equipment, particularly for the chemical industries.

Heating and ventilating engineers especially will find much helpful and interesting material in the chapters dealing with riveted pressure vessels, welded pressure vessels, piping, attachments and closures, and threaded fasteners. In the discussion of piping, for example, there is presented information that may have escaped the busy engineer, on the new classification of pipe by weights and working pressures, set up by the American Standards Association and based on the so-called schedule numbers, instead of on the old extra heavy and double extra heavy terminology. The book also gives information on nonferrous piping, tubing, and other conduit for fluid flow.

Other chapters discuss materials of construction; mechanical properties and strength of materials; mechanics and structural analysis; belts, chain drives, gearing, shafting and bearings; steel, nonferrous, concrete and wood construction.

The book contains 580 + viii pages, 6 x 9 in., is published by D. Van Nostrand Co. Inc., 250 Fourth Ave., New York, N. Y., and sells for $7.50—*K. S.*

Arc Welding Handbook

Because of the war, arc welding has progressed rapidly with many new applications and techniques having been developed, and it therefore seems timely that the eighth edition of the Procedure Handbook of Arc Welding Design and Practice is now available.

The book has been entirely revised to include the latest data on new arc welding methods and equipment and represents the efforts of hundreds of contributors. Many new illustrations covering significant applications developed in various phases of war production, which heretofore have not been published, are incorporated. In addition to standard data on welding symbols, speed and costs, characteristics of metals, preheating, stress relieving, approach to welded design and other pertinent information, the newly revised handbook includes 16 new subjects among which are new cost tables, new welding techniques, mathematical calculations for new weld-designed structures, latest steel specifications on SAE and AISI including national emergency steels, shop ventilation, maintenance of welding equipment, methods of testing, and filler specifications for electrodes.

As in previous editions, many illustrations and examples are used throughout to clarify this comprehensive text which is divided into eight principal sections covering the following subjects: 1. Welding methods and equipment; 2. Technique of welding; 3. Procedures, speeds and costs; 4. Weld metals and methods of testing; 5. Weldability of metals; 6. Welded steel construction—machine design; 7. Designing of arc welded structures; 8. Typical applications of arc welding manufacturing, construction and maintenance.

In the progress report supplement to the procedures, speeds and costs section of the seventh edition, the "fleet-fillet" technique for speeding war production and cutting costs was introduced. In keeping with this trend, which has now passed beyond an advanced experimental stage, many of the charts and tables appearing in this new edition of the handbook have been revised to reflect greater arc speeds. Procedures for the most economical joining of plate and sheet metal are discussed on pp. 178 to 186 and are based upon the fundamental thought that "For years, perfectly sound welds have been made by conventional methods with the accepted thought that slower speeds give greater penetration. However, facts show that faster speeds give greater penetration, while the slower speeds tend to build up more of the metal on the surface. A fillet weld with greater penetration, resulting from faster travel speed, appears smaller but its strength actually is as great or greater than the weld made at slow speed with a sacrifice of penetration for build up.—This method of utilizing the greater penetration resulting from faster arc speeds to obtain the required weld strength is the fundamental basis of the modern welding technique."

While the section devoted to typical applications of arc welding has been somewhat modified, that portion describing piping is essentially the same as in the previous seventh edition. In addition to a general discussion of welding as applied to various types of piping, tabulated data for arc speeds, electrode sizes, required numbers of beads or passes, weld and groove specifications, a cost comparison chart for welded versus threaded and flanged joints, and templates for pipe joint layouts are included.

The eighth edition of the Procedure Handbook of Arc Welding Design and Practice, which contains 1312 + XII pages, 6 x 9 in., and 1647 illustrations, including photos and drawings, should be a welcome addition to the library of everyone interested in the welding process. It is published by the Lincoln Electric Co., Cleveland, Ohio, and has a semi-flexible simulated leather, gold embossed cover. The price per copy, postpaid is $1.50 in the United States and $2.00 elsewhere.

Refrigeration and Air Conditioning

Audel's Refrigeration and Air Conditioning Guide, by Edwin P. Anderson, is but one in a series of many of the publisher's handbooks for mechanics. For anyone unfamiliar with this field and wishing to obtain practical information from the serviceman's or installation mechanic's standpoint, the book undoubtedly provides a brief and elementary introduction.

The author begins with simple definitions of units of measure, Boyle's and Charles' laws, and proceeds with an elementary description of the fundamentals of refrigeration. Among the subjects discussed throughout the book are refrigerants, compression systems, compressors, controls, installation methods, motors, marine refrigeration, pumps, brine systems, ammonia absorption systems, and cold storage applications. Considerable attention has been given to household refrigerators with piping and wiring diagrams of many of the types commonly found on the market being included. Also stressed is the servicing of domestic units, and commercial cabinets.

Since there is virtually no mention of basic thermodynamic principles and such things as heat transfer, cycle analyses, design factors or data, Mollier charts, temperature-entropy diagrams, pressure-enthalpy relations, the psychrometric chart, and the properties of materials, the book would appear to be of little value to the refrigeration and air conditioning engineer.

The section devoted to air conditioning seems poorly organized in that the greater part of it contains what could best be described as helpful hints for the serviceman. Templates for the more common sheet metal fittings are included together with a brief outline for trouble shooting and a description of the various pieces of equipment commonly used. In addition, some space is devoted to air properties, building heat gains, and duct design. The data and design procedure outlined is incomplete and somewhat confusing. For example, chapter 38 consists of a sample calculation for the cooling load of a small store. From the data included the author calculates (pretty much by rule of thumb) the total heat gain. No attempt is made to determine the sensible heat ratio and the factors used for the sun effect and total heat gain due to infiltration are not clearly set forth. Design procedure and load calculations do not seem to be within the scope of this book.

This 4¾ x 6½ in. handbook contains 1242 pp., is bound with simulated leather, and is published by Theo. Audel & Co., 49 W. 23rd St., New York 10, N. Y. The price is $4.00.

Sheet Metal Theory and Practice

Sheet Metal, by John C. Butler, is a self instruction guide giving methods for handling tools and machines, material allowances, blueprint reading, soldering, fluxes, welded and riveted assembly and many other operations. Mr. Butler is chief quarterman sheet metal worker, personnel assistant to the master mechanic, and supervisor in charge of training in the sheet metal shop, Puget Sound Navy Yard, Bremerton, Washington.

The book has been used to train unskilled and semi-skilled navy yard workers for all types of sheet metal work in a very limited time. The theory and practice described, however, are not limited to any one branch of sheet metal work but are intended for all such workers, whether in government or in private shipyards and plants.

All technical terms, tools, and machinery used in various sheet metal jobs are fully explained, and simple non-technical language is used wherever possible. Line drawings are employed throughout to illustrate many phases of the work. The book (published by John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y.—$3.00) contains 173 pages (8½x11) and a total of 152 cuts, and intends to cover all branches of sheet metal shop work except pattern drafting, which is omitted, the author says, not because of lack of importance but because there are already many excellent texts on that subject available.

Intra-Clothing Climate

A paper on intra-clothing climate, by Paul A. Siple, is an interesting feature of a publication of the National Research Council of the National Academy of Sciences, Washington, D. C., which gives the 1944 transactions of the American Geophysical Union.

The intra-clothing climate zone lies between the body and the atmosphere and has a multiplicity of characteristics all its own, says the author.

The importance of studying clothing as a science was hardly realized before the war, but the need for determining climatic phenomena in the intra-clothing layers has become a primary problem of the Quartermaster Corps.

Cast Metals Handbook

The importance and usefulness of technical data on cast metals are reflected in the fact that in nine years, the Cast Metals Handbook of the American Foundrymen's Association has had four editions. The rapidly changing technology of metals casting is probably the principal cause of the frequent revision of this fundamental text.

There are four major divisions to the book: cast steel, malleable iron, cast iron, and nonferrous alloys. Minor but effective treatment is given also to casting design, casting specifications and purchasing practice, and significance of testing. The method of presentation in each major section is to consider general information, methods of manufacture of the metal, metallurgy (really metallography), properties, technical data and applications.

A staff of experts wrote the text, each topic having the benefit of a specialist in that field. Throughout, the text is practical in style, suited to the everyday needs of the operating foundryman. Primarily, it is devoted to sand casting. Metal mold casting is touched upon, both as to data and technique, but not in any complete or adequate manner. As a whole, the handbook carries two distinct and convincing impressions—the foundryman is making diligent and successful effort to place foundry practice on a sound engineering foundation; nevertheless, the experience and practical knowledge of the foundryman are still indispensable to successful foundry operation.

The book has 745 pages, 6 x 9 in., and two inserts of metallographic plates. The price is $6.00. It may be ordered from the AFA, 222 W. Adams St., Chicago 6, Ill.

Restrictions on Coal and Coke Shipments Cancelled

Effective November 1, Solid Fuels Administrator Harold L. Ickes cancelled most wartime controls over shipments of anthracite and coke by producers and wholesalers to retail dealers, thus returning to industry the primary responsibility for distributing these fuels. The SFAW, however, retained in full effect regulations which will enable it to divert shipments of fuels this winter whenever necessary because of emergencies, and field offices together with local committees of the SFAW will be maintained throughout the eastern half of the nation for the purpose of taking whatever action may become necessary to aid communities in obtaining adequate coal. Regulations governing deliveries by retail dealers already have been abolished throughout the country.

The administrator announced that he had signed orders, effective November 1, which: 1. abolish detailed controls over shipments of anthracite by producers and wholesalers, including ash limitations, excepting that modified reports showing production and distribution must still be filed with the government; 2. abolish detailed controls over the distribution of byproduct coke at the wholesale level, and ash limitations on reclaimed coke; 3. abolish regulations giving poultry brooders and hatcheries priority in obtaining domestic anthracite; 4. continue in existence the national anthracite distribution committee and the regional anthracite distribution committees, which advise SFAW on hard coal distribution problems.

OPA Liberalizes Price Policy on Building Equipment

Manufacturers of mechanical building materials such as boilers, radiators, plumbing fixtures, and valves, may apply for price increases when they face overall loss, whether or not the products involved qualify as "essential" or as "low priced." In an action effective October 25, the OPA liberalized the relief provisions of the mechanical building materials regulation to bring them in line with provisions being added to the regulation governing brick, sand, gravel and refractory materials. Similar provisions, says the OPA, are open to manufacturers of a variety of consumer and industrial materials under the general relief order of September 15.

EQUIPMENT DEVELOPMENTS

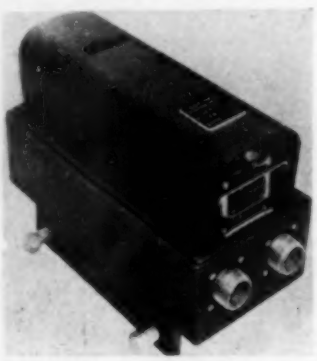
For your convenience in obtaining more information about any of this equipment, see coupon on this page. Add the new products and companies listed here to your Directory Section which you received in your January 1945 Heating, Piping & Air Conditioning and thus keep your records of sources of supply up to date throughout the year. Single asterisk indicates equipment not listed in Directory Section; double asterisk equipment and manufacturer not listed.

Humidity Recording and Control in Navy's Preservation Program

No. 2924—New developments in dehydration and related control equipment now make it possible for the Navy to preserve decommissioned vessels for 20 years or longer with economy and efficiency never before achieved, says Capt. H. Gordon Donald, demobilization officer of the Navy Bureau of Ships. "The Navy's prime considerations in the reserve fleet program," Capt. Donald said, "are to safeguard these vessels against deterioration at a minimum cost in materials and manpower required for maintenance and inspection, and to insure that they can be speedily returned to active service, if the need arises, in a matter of days instead of months."

As the result of more than 20 years of combined research with leading firms manufacturing dehumidification equipment, the bureau has developed a number of systems for drying the air in enclosed spaces aboard ship. In addition, as the result of extensive investigation, the bureau has determined that a relative humidity of 30 per cent or less, together with application of suitable rust preventive compound on machinery, ordnance equipment, etc., will be satisfactory for resisting rust and corrosion.

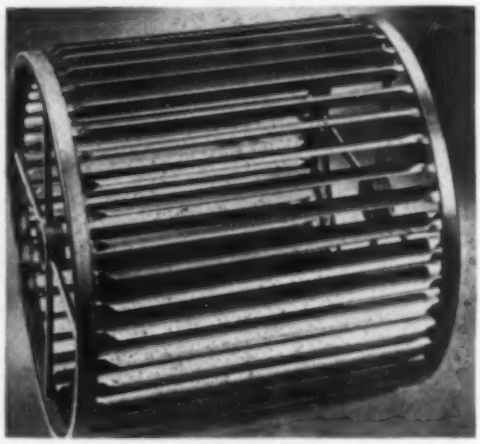
To meet the recording and control problems involved with the dehumidification of naval vessels, the Friez Instrument Div., Bendix Aviation Corp., Towson 4, Md., in conjunction with the bureau, developed a unit which takes accurate humidity readings from eight locations in various parts of a ship and transmits the data to a central recorder station. Instead of being recorded on a graph, the humidity readings, station numbers, dry bulb temperature, and the time of reading are printed in numerals on a tape so as to form a permanent record which can easily be understood by clerical workers. In addition to taking continuous temperature and humidity readings at the various single stations, the central recorder automatically computes the average relative humidity for the eight readings. When the average relative humidity exceeds 30 per cent, the unit causes the dehumidification equipment to function until that humidity level is reached, when the unit then merely acts as a recorder.



The first of these controller-recorder units to be used by the Navy is being installed on the 10,000 ton cruiser, USS Brooklyn, which is being used as a demonstration ship for the extensive dehumidification program. The tall cabinet unit, shown here, is the central recorder and the other illustration shows the distant measuring station unit.

Centrifugal Blower Wheel

No. 2925*—Production of a new centrifugal blower wheel, for which patents are pending, has been announced by the Mayne Products Co., 324 Harries Bldg., Dayton 2, Ohio. The end ring construction provides a large area for air to enter, thus reducing entrance losses and making more effective use of the overall blade area. Another feature is the hook and lock construction of the wheel, which is said to give added rigidity and uniformity in production. A machine which locks the blades in place in one operation reduces assembly time in production. According to the manufacturer, the improved design of the wheel provides quiet operation and high pressures, as well as reduced horsepower requirements.



Vertical A-C Motor

No. 2926—A new addition to its line of protected type a-c motors has been announced by the Crocker-

Heating, Piping & Air Conditioning, [10-45]
6 N. Michigan Ave., Chicago 2, Ill.

Please ask the manufacturers to send me more information about the equipment mentioned under the following reference numbers in Equipment Developments and Recent Trade Literature.

(Circle each number in which you are interested)

2924	2925	2926	2927	2928	2929	2930	2931	2932	2933
2934	2935	2936	2937	2938	2939	2940	2941	2942	2943
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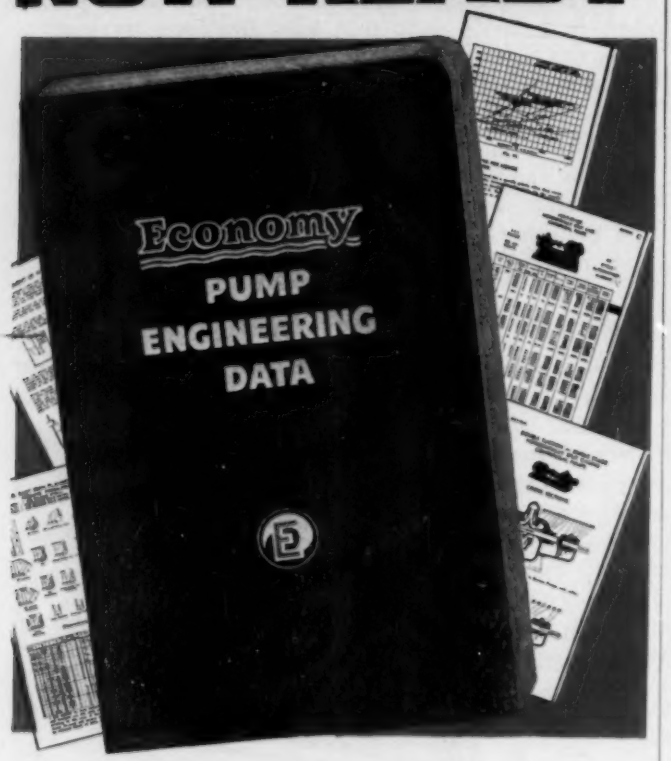

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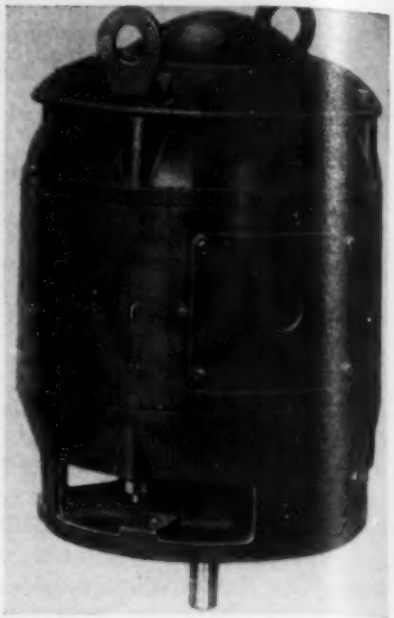
HAMILTON, OHIO • U. S. A.

OVER THIRTY YEARS MAKING BETTER PUMPS TO MOVE

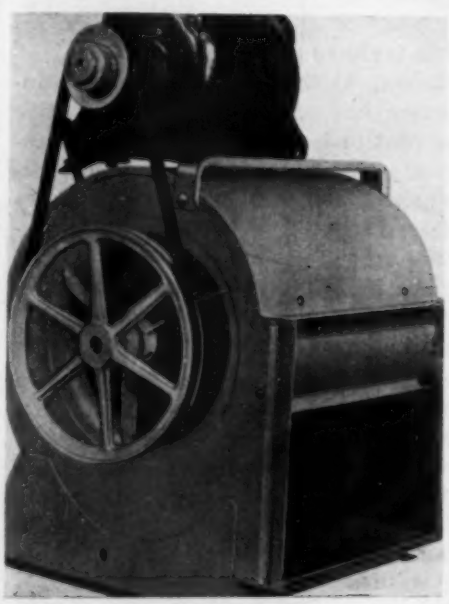
Wheeler Electric Mfg. Co. Div. of the Joshua Hendy Iron Works, Ampere 1, N. J. It is a vertical drip-proof model, rated at 40 C rise continuous duty with a 15 per cent service factor, and is designed for operation from 60 or 50 cycle, 3 or 2 phase circuits, at all standard voltages.



All ventilating openings are shielded against the entrance of dripping liquids and falling particles. Oversize ball bearings are provided to carry thrust in addition to the rotor, and the use of a centrifugal bearing seal permits using softer grease for lubrication, says the manufacturer. A recessed junction box provides ample room for making electrical connections. The rotor, with bars, fans, and end rings, is cast in one operation from aluminum alloys.

Blower Assembly

No. 2927—Its first postwar product development, the "A" series blower assembly, has recently been announced by the Lau Blower Co., 2001 Home Ave., Dayton 7, Ohio. Among the features of this unit is a three-point suspension method bearing bracket, the brackets being positively attached to the shroud to form an integral part of the housing. In its fixed position, the bracket is used for various angles of discharge. This bearing suspension is said to maintain positive alignment of the blower wheel to the venturi.

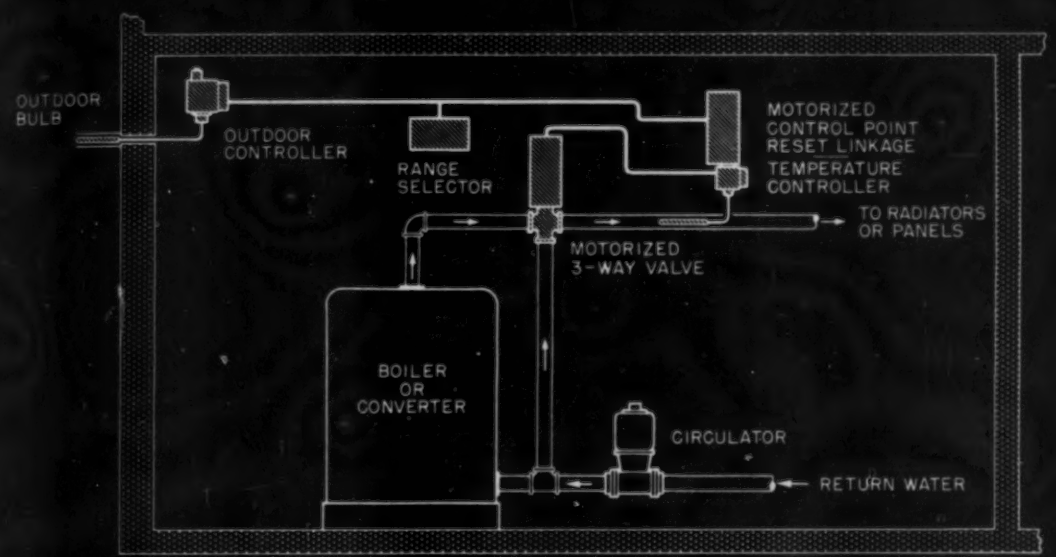


A method of mounting the motor is provided in a single attachable piece which is convertible from rear to top position by using two sheet metal screws. Other new developments include a center suspension type wheel for low and high speed; a specially designed housing base; a redesigned scroll with offset in the sides for greater strength; and a discharge outlet con-

Honeywell Offers

for Commercial Hot Water Heating

BOILER CAPACITY MATCHED TO VARYING OUTDOOR WEATHER



This application of the Moduflow system to commercial hot water heating virtually changes the size of the boiler to fit the weather. In effect, the boiler capacity is increased in colder weather and decreased in mild weather. Actually, in cold weather, the supply water is modulated hotter to meet the demand and modulated colder as the outside temperature increases. This prevents wasteful and uncomfortable heating in mild weather and insures quick response of the heating system in severe weather.

This new modern Honeywell equipment can be applied to new or existing heating plants. It is adaptable to all types of hot water heating and to all kinds of automatic burners, and is available for single or multiple zone applications.

It will pay you to investigate this control system, which not only produces more even and healthful heat, but saves fuel as well. Write for full information. Minneapolis-Honeywell Regulator Company, 2701 Fourth Avenue South, Minneapolis 8, Minnesota.

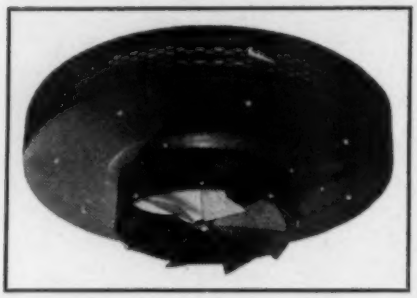
MINNEAPOLIS **Honeywell**

CONTROL SYSTEMS

structed so that the cutoff cannot rest crooked on the outlet. The overall size of the new blower is considerably smaller than former models of comparable capacity, says the manufacturer.

Down Blow Unit Heaters

No. 2928—"Series 12" circular and square model down blow unit heaters have been announced by the Fedders Mfg. Co., Inc., 81 Tonawanda St., Buffalo 7, N. Y. The square type is designed for ceiling heights of 15 to 25 ft, and the circular type for heights from 20 to 45 ft. These heaters are recommended by the manufacturer where clearance for material handling equipment, tall machinery, etc., requires that piping be kept out of the way.



In the circular types, high velocity air discharge delivers heat down into the working zone. Diffusion is accomplished by adjustable directional outlets. Air is taken in at the sides of the heater and delivered down from the center through a streamline shroud. The heating element is made of copper tubes and continuously wound fins with a metal-to-metal bond.

In the square models adjustable louvers allow straight down blow or a four way diffusion of heat. The heating element is made of streamline copper fins and tubes. Tube openings in the headers are flanged to provide contact area for a permanently brazed union between headers and tubes.

Silicone Varnish

No. 2929**—A waterproof silicone varnish ("DC 996") for impregnating electrical equipment has been developed by the Dow Corning Corp., P. O. Box 592, Midland, Mich. Among the advantages claimed for this product, which cures at 300 F, are the following: Protection against failure due to sustained overloads; increased service life of electrical insulation; higher permissible operating and ambient temperatures; increased protection against excessive moisture; elimination of fire hazards resulting from the failure of insulation; and increased power output per unit weight.

The varnish is furnished as a 60 per cent by weight solution in an aromatic solvent and has a viscosity of two to five poises; in this consistency it is suitable for impregnating electrical equipment. It can be reduced to any desired viscosity with aromatic naphtha.

Pipe Plugs and Caps

No. 2930**—A new line of protection pipe caps and plugs has been announced by Tubing Seal-Cap, Inc., 215 W. Seventh St., Los Angeles, Calif. It is claimed that this is the first time that small fittings with fine threads have been stamped. According to the manufacturer, threading or embossing is achieved by a process that eliminates machining and secondary operations and results in the stamping of small parts with continuous threads.

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This ALL-PURPOSE MOTOR will simplify your Designing, Purchasing, Production and Inventory. Check these features with your motor specifications:

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5. End plates interchangeable for face mounting.
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Office buildings, banks, department stores, theatres, libraries, drug stores, business houses of all kinds — from one end of Main Street to the other — are recognizing the importance of *clean air* in their establishments. Economically, *clean air* is saving millions of dollars annually by reducing building upkeep — more millions in reducing merchandise spoilage. Costly dust, soot and smoke need not be tolerated, for AAF Electronic Air Filters are designed to meet every clean air requirement. Send today for free Electro-Matic Bulletin No. 250D — you'll find it helpful in overcoming your dirty air problems.

AMERICAN AIR FILTER CO., INC., 375 Central Avenue, Louisville 8, Kentucky

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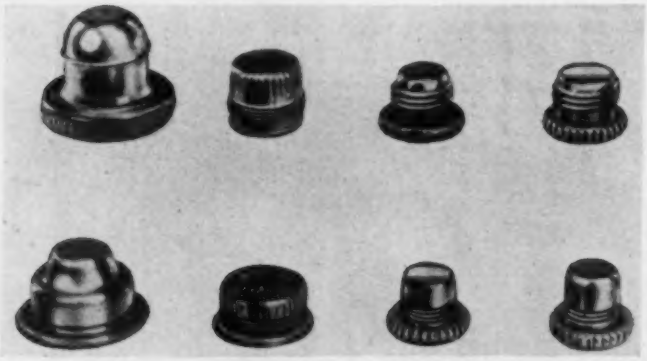
Electro-MATIC

THE AAF ELECTRONIC AIR FILTER



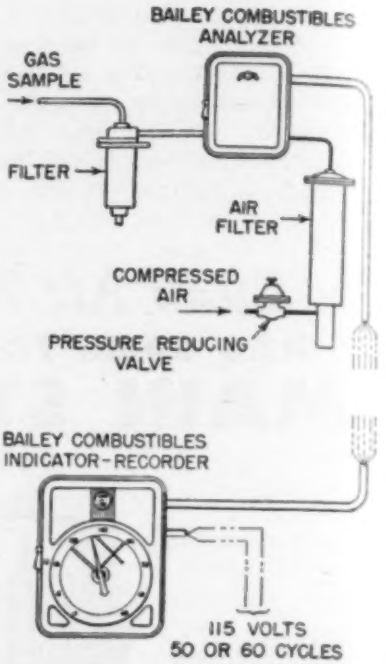
Available at present are protecting pipe plugs and caps with NPT thread sizes up to 1 in., fabricated from steel or aluminum. Larger sizes will be added, and other threaded parts will be made to specifications.

Stoker Firm Expands

No. 2931—Coincident with the termination of war contracts, the U. S. Machine Corp. expanded its "Winkler" stoker division at Lebanon, Ind., to utilize space formerly devoted to the manufacture of munitions. In this space stokers are being assembled on a new line in a department where 3½ million trench mortar, chemical warfare, and rocket shells were produced, even while other workmen are busy dismantling the war production machinery. Plant space has been more than tripled in four years, and the expanded facilities will enable mass production of thousands of domestic, commercial, and industrial stokers each month, says the manufacturer.

Recorder-Controller

No. 2932—An automatic analyzer and recorder for indicating, recording, and controlling the combustibles content of a gaseous mixture has been developed by the Bailey Meter Co., 1050 Ivanhoe Road, Cleveland 10, Ohio. According to the manufacturer, this instrument has been successfully applied to precision control of furnace atmospheres and chemical processes, as well as combustibles measurements in the petroleum, metallurgical, automotive, and chemical industries.



RECONVERSION POLICY—Well-laid plans of the Schaible Company went into action quickly. And the first two items in production are already rolling in volume.

Our ultimate line will be W-I-D-E . . . new models and new items . . . heating field as well as plumbing. But we plan to start production of each item only as it could be maintained on a reasonable delivery basis and be a quality product. This means devoting our full capacity to just a few items at first and then adding others gradually. That is the way we can do everyone the most good so long as scarcities remain—by producing the most volume possible as quickly as possible. And that is best served by large production of fewer items (on scheduled delivery), instead of smaller production of more items (with bad deliveries).

FOR THE PRESENT—First, we are producing faucets and strainers. A Stainless-steel Basket Strainer and Deck-type Sink Faucet (less spray) are in production now. Next to be started will be a Flat Strainer, a Deck-faucet with spray, and perhaps a Lavatory Faucet. Those items are on an allotment plan through our Representatives, who each have a limited quota for the first phase of reconversion, representing our first few months' output. The First Allotment has "booked-up" our output through February.

LATER RECONVERSION—Beyond the above "first phase", the exact timing of subsequent developments cannot yet be predicted accurately. So instead of guessing now, each new development will be announced as it occurs—as our ability to serve improves . . . and as each new item is added to production.

Again we want to thank our customers and other friends for their continued understanding and patience—until that glorious time when patience and special understanding will no longer be necessary.

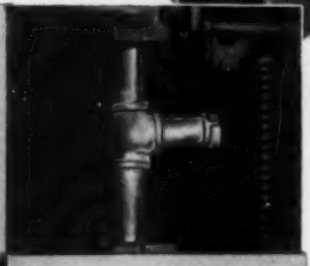
The Schaible Company · Cincinnati 4, Ohio

MAKERS OF QUALITY BRASS GOODS STOCKED BY LEADING WHOLESALERS EVERYWHERE

THE SIL-FOS RING . .

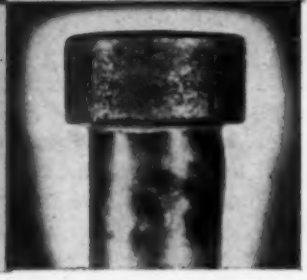
MAKES THE BOND IN THE *Silbraz** JOINT!

STRENGTH →
Thousands of tensile tests prove that SIL-FOS makes Silbraz joints stronger than the metals joined.



← DUCTILITY
The silver content of SIL-FOS gives Silbraz joints exceptional ductility to withstand severe vibration, shocks and temperature changes.

LEAK-TIGHTNESS →
Exacting pressure tests demonstrate the leak-tight quality of Silbraz joints — the result of the complete penetration and alloying action of SIL-FOS.



The **Silbraz joint** is the basic factor in the success of this modern, threadless method of constructing copper and brass pipe and tubing systems.

And an important feature of this strong, leak-tight, time-tested joint, is the **ring of SIL-FOS** inserted in the bores of fittings, flanges and valves developed for installations of this type.

SIL-FOS is the same low-temperature silver brazing alloy whose outstanding strength, speed, reliability and economy have won such wide acceptance throughout industry in joining non-ferrous metals.

It provides you with this exclusive combination of properties—**low flow point** (1300°F.) that saves heat and time and safeguards metals against heat damage—**exceptional fluidity** that gives instant penetration throughout the joint area and an alloying action with metals that assures high strength—**silver content** that results in vibration and shock defying ductility and strong corrosion resistance.

It's these SIL-FOS properties that assure you a permanently leak-tight, maintenance-free installation when you specify Silbraz-Joined pipe and tubing.

*Reg. U. S. Pat. Off.

ARMY NAVY

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Diesel and Fuel Oil Service

No. 2933—An advisory service to oil burner and diesel operators in the form of a diagnosis chart has been developed by the Combustion Utilities Corp., 1451 Broadway, New York 18, N. Y. The chart is to be filled out by the operator, and from this information the company makes recommendations to help solve particular problems. The service is free and without obligation, it is said.

Valve Company Expands

No. 2934—Peacetime demand for the valves and other products that it makes for air conditioning and refrigeration equipment is so great that the Alco Valve Co., 865 Kingsland St., St. Louis 5, Mo., will retain all of its 500 wartime employees and add more, Russell Maguire, owner of the company, announced recently.

Mr. Maguire disclosed that capitalization of the company is being quadrupled by the transfer of funds from surplus to capital and that the enlarged quarters used during the war will be retained. "We will have a substantial increase in our business in the refrigeration field, which has been running $3,500,000 a year during the war," said Mr. Maguire. "We also expect increases in air conditioning and in the hydraulic field and are expanding our operations to meet the needs of jobbers and manufacturers."

Chairman of the board of the company since acquiring it in 1936, Mr. Maguire has become president and general manager. John Dube, Charles B. Lockwood, and Douglas Hammond are vice-presidents. Mr. Lockwood is also secretary-treasurer.

The company designs and manufactures thermostatic expansion, pressure regulating, solenoid, and float valves.

Storing Refrigeration

No. 2935—A patent on methods of storing refrigeration in aircraft stratosphere test chambers has been granted L. R. St. Onge, Philadelphia district engineer of the York Corp., Roosevelt Ave., York, Pa., and assigned to the corporation. The problem solved by the invention was how to change temperatures in a large test space from normal to minus 70 F or lower in a matter of minutes. This was accomplished by building inside the stratochamber a "climb" chamber thermally separated from the refrigeration system.

In operation, the entire chamber, including the climb chamber, is cooled to a temperature considerably below the final temperature to be produced in the climb chamber. Then the climb chamber is isolated by means of dampers from the cooling circuit and heated up to normal temperature by electric heaters. After the test subjects are put into the climb chamber, vacuum pumps and fans are started and dampers opened to admit cold air. A sufficient reservoir of refrigeration is thus built up to reduce the temperature within the climb chamber to minus 70 F in 12 minutes or less. At the same time, pumps evacuate both chambers to simulate the pressure change of plane climb.

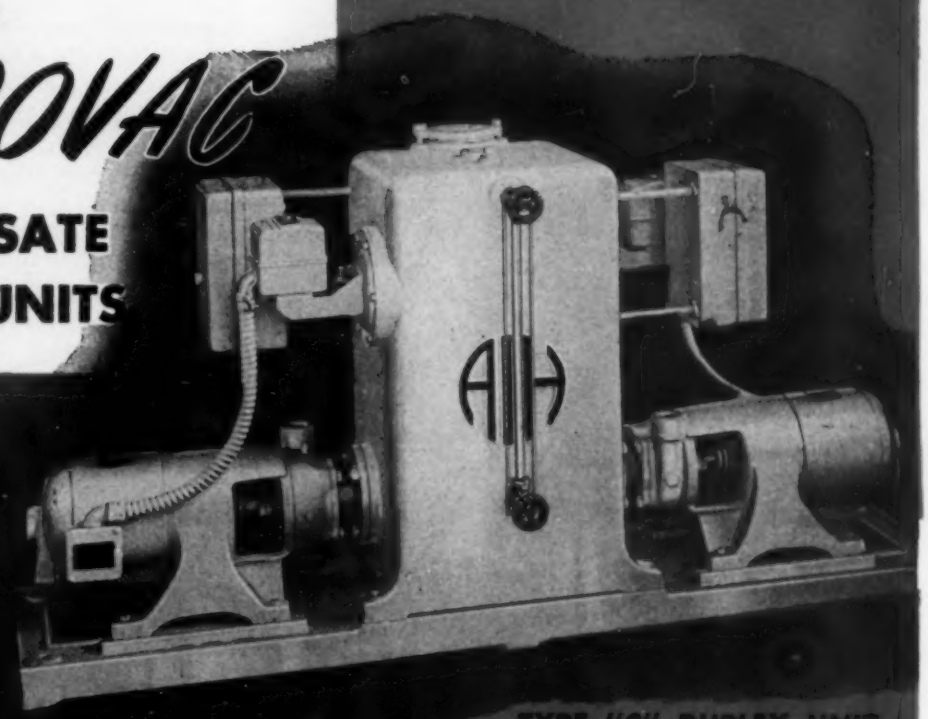
The patents relating to the apparatus cover broadly the combination of a thermally insulated climb chamber of low heat absorption capacity; a thermally insulated stratochamber of high internal heat absorption capacity; the means for abstracting heat and storing

PUMPS BY WORTHINGTON

AMES

HYDROVAC

CONDENSATE RETURN UNITS



LIFETIME PERMOY CAST IRON RECEIVER AND BASE

TYPE "C" DUPLEX UNIT

SUPERIOR BY GUARANTEE!

The 3-year Wear-Proof Guarantee that goes with Ames HYDROVAC UNITS is an extraordinary document. Back of it is the outstanding character of the metals and materials employed in the design and fabrication of this equipment. Plus the many special features built into Ames HYDROVAC Units.

- NEOPRENE WATER SLINGER
- MOTOR VENTILATION PAT. APPLIED FOR
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- LARGE PACKING SPACE
- HYDRAULIC BALANCE REDUCES THRUST

SUPERIOR ON ALL COUNTS

1. High Efficiency
2. Beauty of Design
3. Lifelong Durability
4. Negligible Maintenance Cost

Ask for Bulletin No. 100-A on complete line of HYDROVAC VACUUM RETURN UNITS

Write for Bulletin No. 200-A Showing Consultants' Specification Form, Standard Ratings and Blueprint

AMES HYDROVAC INC.

290 SCHOLES STREET BROOKLYN 6, N. Y.

refrigeration in the stratochamber; transferring heat rapidly from the climb chamber to the entire chamber and alternatively isolating them from each other; and the means to heat the climb chamber.

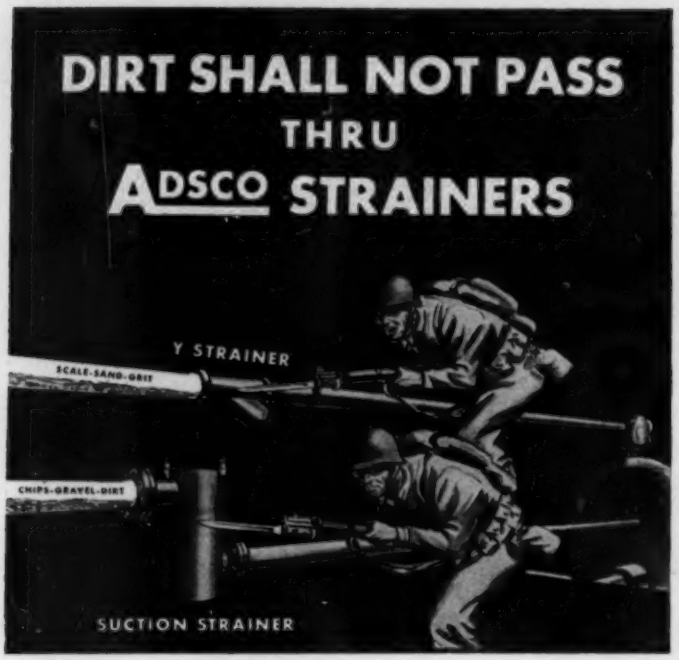
Expansion Foreseen in Chemical Industry

No. 2936—Prospects of expanding employment in the chemical industry were described as "extremely encouraging" by Lammot du Pont, chairman of the board of E. I. du Pont de Nemours & Co., Wilmington, Del., in a recent radio interview. More than half of the company's own employees are engaged in making products new or substantially new since 1928, and more than a fourth owe their jobs to materials which did not exist as late as 1930, he said.

The company expects a sales volume in two years which will exceed 1939 totals by as much as 50 per cent, and that sales in new prewar and postwar products together should equal the entire 1939 output of older products within five years. "Never before in history have we had such a combination of skilled labor, productive capacity, managerial ability, scientific research facilities, and such a backlog of demand for goods and services. Never have we had such an accumulation of buying power or so wide a distribution of it in the hands of the public," Mr. du Pont commented.

Specific Gravity Indicator

No. 2937—A specific gravity indicator, designed for continuous indication of a flowing sample, has been an-



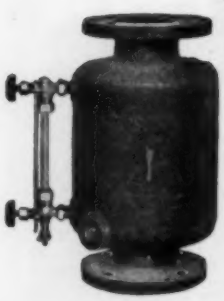
Prevent shutdowns — prolong the life of equipment — increase steam efficiency with ADSCO Strainers and Separators.

The Y Strainer has a screen that is held in place by a removable plug that permits easy removal for cleaning. It protects traps, regulators, valves and other equipment from the wearing and destructive action of foreign matter.

The Suction Strainer does likewise for pumps and other heavier equipment where bulk liquid is contaminated with foreign matter.

Nor Shall Moist Steam Lower the Efficiency of Your Steam Consuming Equipment.

ADSCO SEPARATORS



Remove oil and water from steam — increase its efficiency by delivering it dry.

Right—Horizontal Type

Left — Vertical Type for either up flow or down flow.

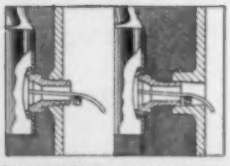
Write for prices.

PROTECT VALUABLE EQUIPMENT ... INCREASE STEAM EFFICIENCY WITH ADSCO STRAINERS and SEPARATORS

AMERICAN DISTRICT STEAM COMPANY
NORTH TONAWANDA NEW YORK
Makers of "UP-TO-DATE" Steam Line Equipment for Over 65 Years

DISTINCTIVE FEATURES — The soft steel blades are made in pairs, pressed thru slots in the heavy steel back plate, then welded to the plate. The blade tips are pressed thru slots in the inlet disc then bent back against the spring of the steel blades. This ***patented construction*** results in an exceptionally rigid wheel and ***prevents loose blades,*** as no rivets are used in fastening the blades. The heavy cast iron machined hub is riveted to the back plate and will not crack or become loose on the shaft.

Janette
Janette Manufacturing Co. · 556-558 W. Monroe St. · Chicago



NEW, IMPROVED HINGED TONGUE
Diagrams above show how Hoffman Hinged Drainage Tongue construction adapts itself to radiators equipped with various boss lengths. It is a major improvement, assuring good drainage under all conditions of service. An exclusive Hoffman feature.

ADJUSTABLE VENT PORT
Comparative tests show the Hoffman vent port adjustment to provide a smoothly graduated rate of venting in direct proportion to the size of the opening. Adjustable to prevent waterlogging, spitting and rumbling caused by too fast venting.

Your prospects for an immediate big sale of vent valves have never been brighter! Fuel must be conserved . . . and in steam heating systems, proper venting is the first step. Hoffman Valves are ready for the job with a full line of units for venting mains and radiators.

In spite of war conditions which have affected the design and quality of many products, Hoffman Vent Valves still offer the superior operating features which have made them the standard of performance for so many years. Double Air Locks —Short-Tongue Siphons—and Six Speed Venting are a few of the reasons why Hoffman Valves help to get full value from fuel burned.

Wholesalers now have full stocks—you can start any time to cash in on the genuine need for steam system renovation. For complete information on Hoffman Main and Radiator Vent Valves, send for new illustrated catalog.

HOFFMAN VENT VALVES

Controlled Heating

STEAM HOT WATER

HOFFMAN SPECIALTY CO., 1001 YORK ST., DEPT FG-11, INDIANAPOLIS 7, IND. MAKERS OF VALVES, TRAPS, HOT WATER HEATING SYSTEMS, VACUUM AND CONDENSATION PUMPS . . . SOLD BY LEADING WHOLESALERS OF HEATING AND PLUMBING EQUIPMENT.

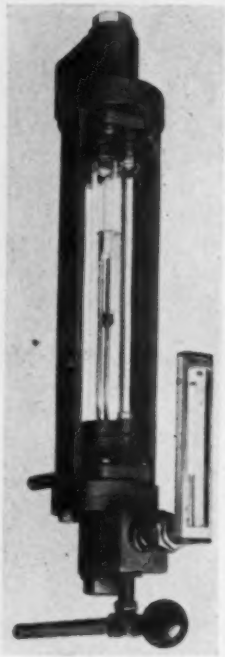
Just use it once—

The Alnor Velometer

gives you instantaneous, direct readings of air velocity in feet per minute. Hold it in the air stream for low range readings; use the tube-connected special jets for high range readings or inaccessible locations. That's all there is to it, and once you use the Alnor Velometer you will never tolerate other methods.

The Alnor Velometer is built in several standard ranges from 20 fpm to 6,000 fpm, and up to 3 inches static or total pressure. Special ranges available as low as 10 fpm, and up to 25,000 fpm and 20 inches pressure. Write for Velometer bulletin.

ILLINOIS TESTING LABORATORIES, INC.
420 NORTH LA SALLE STREET
CHICAGO 10, ILLINOIS



nounced by the Schutte & Koerting Co., 12th and Thompson Sts., Philadelphia, Pa. Flow to the indicator is regulated by a valve. Liquid rises in the glass tube to a height determined by outlet pipes, overflows, and is returned to the process. Specific gravity is indicated on a standard hydrometer within the tube. An integrally mounted thermometer provides for convenient temperature measurement when the hydrometer is read.

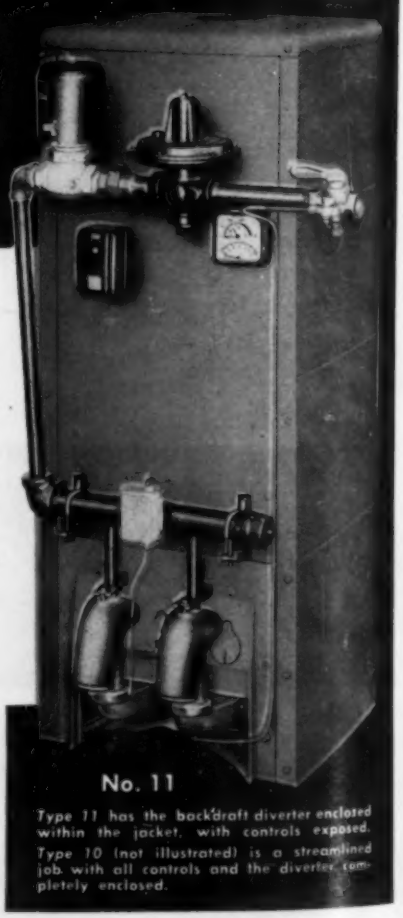
An adaptation of the "rotameter," the indicator is readily installed in new or existing pipe lines, says the manufacturer. Both inside and outside cleaning is said to be easily accomplished without disturbing pipe connections. Packing glands are adjusted by cap screws.

D-C Solenoids

No. 2938**—Four new models of d-c solenoids adaptable for use as air conditioning, heating, and automatic valve controls have been announced by the West Coast Electrical Mfg. Co., Los Angeles 3, Calif. The smallest model, weight 1.5 oz, has a lift of 2.5 lb at ⅛ in. stroke, and is rated at 24 volts, 0.8 amp, instant duty. A second model, weight 4 oz, has a lift of 4 lb at 1/16 in. stroke,

For successful gas heating installations —get up to date on Mueller's new *Climatrol* Gas Boilers

Reg. U. S. Pat. Off.



No. 11

Type 11 has the backdraft diverter enclosed within the jacket, with controls exposed. Type 10 (not illustrated) is a streamlined job with all controls and the diverter completely enclosed.

Write for new Bulletin F-320, "Facts and Figures, Types 10-11-20 Gas Boilers"

Write for "Facts and Figures" Bulletin

Today, your customers expect real improvements in the equipment you offer — better appearance, better performance, new features. That's what you get when you sell the new series of Mueller Climatrol Gas Boilers. Completely redesigned and restyled — equipped with a new, exceptionally quiet burner and many other features — these new boilers live up to Mueller's reputation for leadership in gas-heating progress. New "Facts and Figures" Bulletin No. F-320 describes the various types. (Type 10 and 11 for residences and smaller commercial jobs, Type 20 for the larger jobs). Write for your copy. *L. J. Mueller Furnace Co., 2007 W. Oklahoma Ave., Milwaukee 7, Wis.*

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GAS BOILERS

E-19

A COMPLETE TESTING PROGRAM FOR THE REFRIGERATION AND AIR CONDITIONING INDUSTRY PLANNING TOMORROW'S UNITS

We offer a three-point Testing Program to the Refrigeration and Air Conditioning Industry facing the greatest era in its history:

TESTING . . . Deep freeze units, household units, milk coolers, beverage coolers and dispensers, air conditioning units, display cases, and their component parts (condenser units, evaporators, expansion valves, etc.) are tested for capacity, rating, efficiency, ice making rate, and endurance or life expectancy. Our special rooms are equipped to Test at ambient temperatures of 70 deg. F. . . . 90 deg. F. . . . 110 deg. F., or at your specified temperature.

PRODUCT DEVELOPMENT . . . our engineers work with you in developing new products to meet tomorrow's needs . . . either in your plant or in our completely equipped laboratories.

CERTIFICATION . . . We check your equipment against the guarantee and certify it, if warranted.

Check your new designs and developments!

CERTIFIED MERCHANDISE · UNITED STATES TESTING CO. INC. · SEAL OF QUALITY

UNITED STATES TESTING COMPANY, Inc.

ESTABLISHED 1880

HOBOKEN, NEW JERSEY

PHILADELPHIA, PA. · BOSTON, MASS. · WOONSOCKET, R. I. · CHICAGO, ILL. · NEW YORK, N. Y.

New Protector & Depth Gauge Ends Drill Breakage!

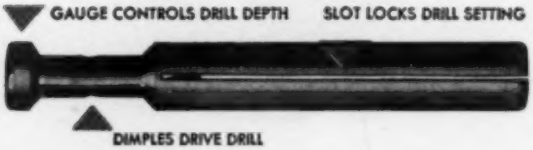
DIMPLES DRIVE DRILL CLOSE TO POINT WHERE WORK IS BEING DONE

GAUGE CONTROLS DEPTH OF HOLE...SPEEDS UP DRILLING TIME

NOW YOU CAN drill faster—*and not worry about drill breakage!* The Hartwell Protector & Depth Gauge protects drills at their weakest point, prevents them from bending or breaking. Equally important, it controls depth of hole or travel of drill.

The Hartwell Protector & Depth Gauge improves drilling accuracy . . . saves drills . . . cuts drilling costs . . . reduces lost time on the job. Its rounded nose protects the drilled surfaces.

The Hartwell Protector & Depth Gauge is available in 15 sizes from 1/16 through "F." Sizes 1/16 through 10 are held to ¼" o. d. to fit standard drill chucks. Larger sizes are held to ⅜" o. d.



ASK YOUR JOBBER about the new Protector & Depth Gauge

Single source for 779 production parts and tools

HARTWELL
ENGINEERING COMPANY
Designers • Manufacturers • Distributors
3417 Crenshaw Boulevard, Los Angeles 16, California
Dallas, Texas • Kansas City, Kansas

and is rated at 24 volts, 0.35 amp, continuous duty. The third model, weight 8 oz, has a lift of 20 lb at 1/16 in. stroke, and is rated at 24 volts, 4.5 amp, continuous duty. The model shown, weight 2 lb 1 oz, has a lift of

60 lb at ¼ in. stroke, and is rated at 24 volts 12.5 amp, intermittent duty. All weights are with plunger.

According to the manufacturer, these solenoids are lightweight, easy to mount, vibrationproof, and are sealed against gases and inflammable liquids.

Pipe Line Strainer

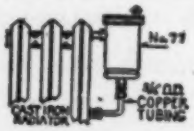
No. 2939—The addition of the new "Low-Swing" strainer to its line of "Ezy-Kleen" strainers has been announced by the Blackmer Pump Co., 1920A Century Ave., S. W., Grand Rapids 9, Mich. The use of perforated steel or bronze for the strainer basket is said

And Keep It Out With

AUTO-VENT AIR ELIMINATORS

CIRCULATION TROUBLES?

Don't fight air pockets or traps in hot or cold circulating lines! "Get that air out of there" *and keep it out* simply by installing the No. 7 Maid-O-Mist Automatic Air Vent. This reliable air vent has a self-closing float-controlled valve and is designed especially for circulating pipe lines, convector radiators, unit heaters, cooling manifolds, tanks, diesel engines, or any other application where air pockets or traps retard the free circulation of liquids. For pressures up to 75 lbs. Now available in bright brass finish.



Venting Cast Iron Hot Water Radiator

PLAY SAFE—USE THEM ON EVERY JOB

MAID-O-MIST INC.
3215 N. PULASKI RD., CHICAGO 41, ILLINOIS

AUTOMATIC HUMIDIFIERS
FOR ALL TYPES OF HEATING SYSTEMS

Mister, now's the time to figure on

Horsepower by Howell

The Howell Protected Type Motor, shown, gives complete protection against dripping liquids, metal chips and other falling particles. Completely streamlined—utilizing non-breakable steel frame—malleable or steel base—cast iron end plates and cast iron, weatherproof terminal box are standard construction features. Special horizontal and vertical mountings are available. *Available in sizes 5 H.P. and smaller. Other sizes and types available up to 150 H.P.*

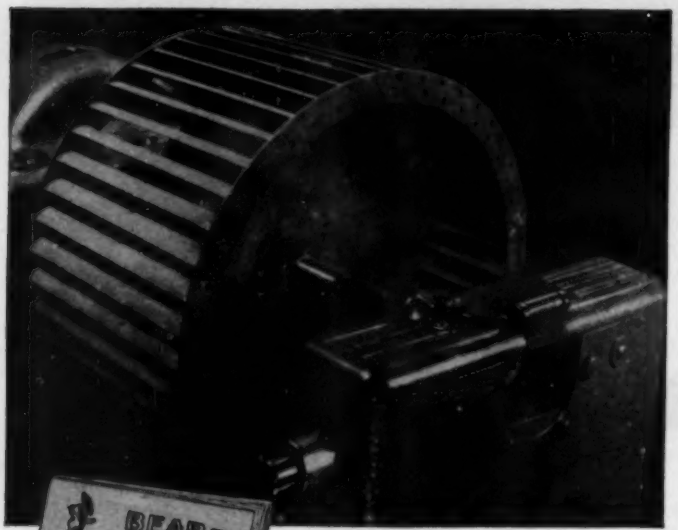
Years of building Howell Motors, to meet the exacting requirements of the automotive, dairy, food and other important industries, have enabled us to make them better than ever. Today, as always, Howell Motors are quality-motors. They are quiet-operating because they are statically and dynamically balanced. They are better performing because they are built of the finest materials—copper or bronze rotors—and completely insulated. They are trouble-free on the job because they are designed for the toughest tasks in industry—consequently, they perform better on all jobs. For your postwar need in specialized or standard motors, from ¼ to 150 h.p., phone the nearest Howell Representative today.

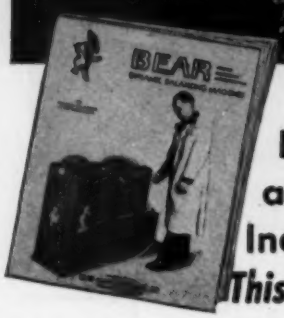
HOWELL ELECTRIC MOTORS COMPANY

HOWELL, MICHIGAN

Manufacturers of Quality Motors Since 1915

Now, a Better Way to lick trouble-making "WOBBLIES"





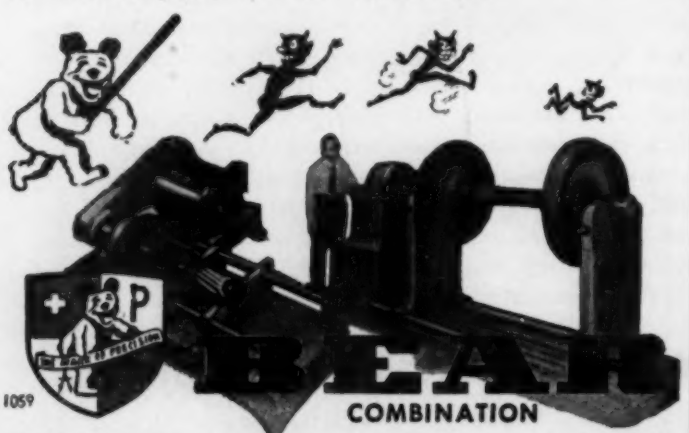
Users Report Bear Dy-Namic Balancing an Easier, Quicker and Inexpensive Operation! *This Free Bulletin Tells Why!*

Remarkable increases in the life of parts and machines, reductions in vibration and vibratory noise, and savings in maintenance are reported for equipment where rotating parts have been Dy-Namically Balanced!

Static Balance has been proven inadequate for today's machine speeds! Dy-Namic Balance, long known to engineers as important, is *now made practical* through the development of the Bear Dy-Namic Balancing Machines which

CUT TIME AND COST OF DY-NAMIC BALANCING!

For a full description of this fast growing industrial technique for which operators can be trained in a few hours, write for the BEAR DY-NAMIC BALANCING BULLETIN. Included is data on a complete line of machines for balancing everything from tiny armatures to railroad wheels! Address Bear Mfg. Co., Dept. HPA, Rock Island, Ill.



1059

COMBINATION

STATIC AND DY-NAMIC BALANCING MACHINES

to make it less likely to be damaged in cleaning and to give it longer life. Slotted lugs on the top plate line up with the lugs of the body to receive the four holding bolts, an arrangement that permits quick removal of the basket for cleaning.

The strainer is designed for flange mounting, and companion flanges are included with the unit. It is compact enough to permit mounting in a small space or in lines along walls, says the manufacturer. Capacity of the unit now being produced is 100 gpm with 2, 2½, and 3 in. intake and discharge sizes. Maximum operating temperature is 600 F; maximum pressure 75 psi.

Axial Flow Fans

No. 2940—Advancements and developments in the axial flow fan field will be announced in the near future, according to the La-Del Conveyor & Mfg. Co., S. Broadway and Mill Ave., New Philadelphia, Ohio. Research work continued during the war, when the fan division's entire production went to the Navy, and new models are now being prepared for industrial, mining, and domestic use, says the manufacturer. Fred W. Blaisdell has been appointed plant manager.

Open End Socket Wrenches

No. 2941**—Open end reversible ratchet wrenches for running and tightening nuts on tubing, cables, shaft fittings, protruding studs, or other operations where the conventional socket wrench cannot be used have been announced by the Tubing Appliance Co., 3881 Victoria Ave., Los Angeles 43, Calif.

The socket in these wrenches encircles the tube,

QUALITY *always wins!* MARTOCELLO Products are fully DEPENDABLE

ATOMIZING SPRAY NOZZLES, SPRAY POND NOZZLES, and CONDENSER WATER DISTRIBUTORS
For Vertical Shell and Tube Ammonia Condensers

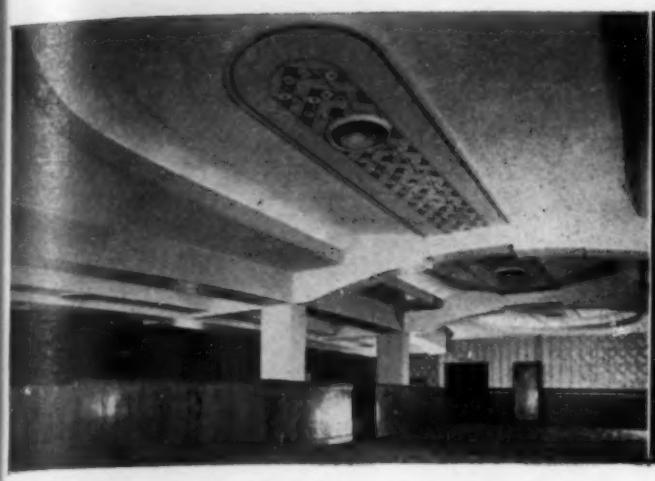
ALL MARTOCELLO SPRAY NOZZLES are manufactured with precision and of a design which has been thoroughly tested for maximum results and durability. They are guaranteed to give satisfaction. Successful, efficient results depend largely upon selecting the proper number, type and size of Nozzles suitable for your installation.

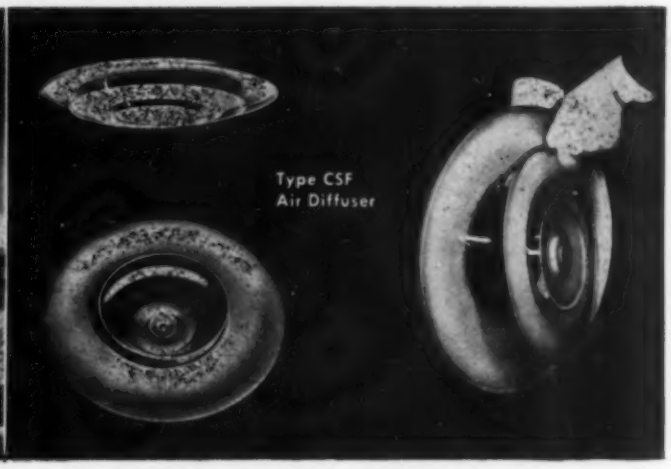
THE MARTOCELLO CONDENSER WATER DISTRIBUTORS are now used as standard equipment by Progressive Refrigerating Engineers in solving their Manpower problem, because they require no attention and assure users of the lowest Condenser Operating Pressures and Minimum Power Cost.

It will pay you to consult us. WRITE or WIRE for further information

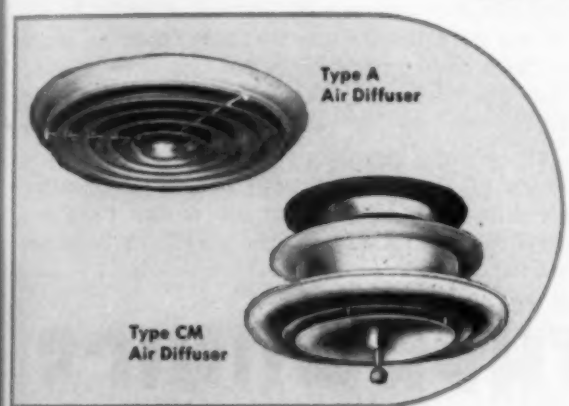
Jos. A. Martocello & Co. 229-231 NORTH LINE STREET PHILADELPHIA 7, PA.

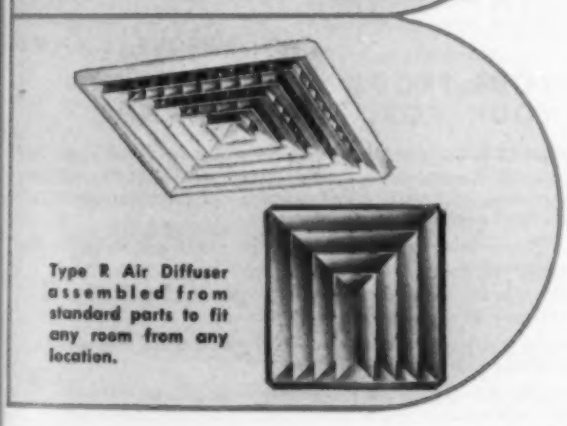
Serving the Ice Industry Since 1918 "There is no Substitute for MARTOCELLO QUALITY"





Beauty plus Simplicity
WITH AGITAIR DIFFUSERS





You can depend on Agitair's high performance, too. That's because Agitair's restricted-type orifices are carefully designed to utilize *all* the energy of the incoming air for rapid mixing and thorough circulation—with no noise, no drafts, and no hot or cold spots.

High-velocity streams of incoming air set up turbulence *outside* the Agitair. It's this turbulence that rapidly, forcibly, mixes incoming with room air, and it's the high energy that circulates and aspirates the air.

Agitairs are so simple they can be installed with a few quick fastenings. Exteriors give you maximum beauty for any job.

Specify Type R Rectangular Diffusers for average rectangular or L-shaped rooms, and for off-center or sidewall mounting; Agitair Circular Type CSF or Type A for large areas or square rooms; Type CM and Navy Standard for marine.

WHAT AGITAIR ENGINEERING MEANS TO YOU—

Every feature of Agitair products has been designed and tested by experienced engineers for maximum on-the-job performance. Agitair representatives are ready to help you plan the job right by recommending the proper type and size. Ask for the Agitair Diffuser Design Data Book.

AT KEY POINTS IN AIR CONDITIONING—AGITAIR SERVES BEST

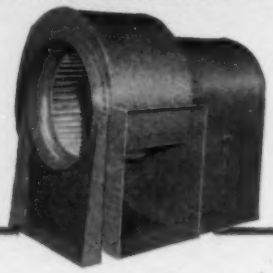
AIR DEVICES, INC. · 17 EAST 42nd STREET · NEW YORK 17, N. Y.

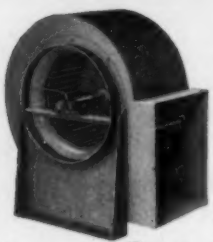
MAKE YOUR VENTILATING JOBS

Peerless Electric

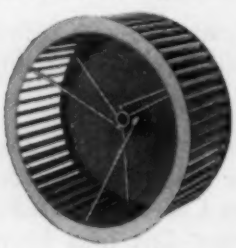
and get the benefits of 50 years' experience in building quality motors and electrical apparatus

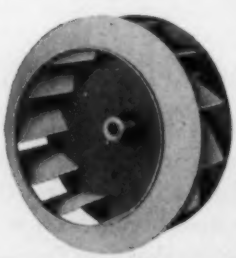
• 26 BELT DRIVE SIZES
• 12 DIRECT DRIVE SIZES





Peerless Electric
VENTILATING BLOWERS
SIZES 12" to 48"
Shown here in Arrangement 3





Peerless Electric
BLOWER WHEELS
Forward curve and backward curve blower wheels full welded construction carefully balanced for smooth, quiet rotation.

Peerless Electric
VENTILATING SETS
Belt drive units are powered with ½ to 7½ h.p. motors; direct drive units ½ to 2 h.p. motors. All units supplied with or without weatherproof hood covers for drive mechanism.

NO matter what your needs—for small jobs or large jobs—it will pay you to make Peerless your headquarters for ventilating equipment. More than 50 years of experience have given Peerless Electric the "know-how" that enters into the design and manufacture of Peerless Electric fans, blowers and ventilating equipment, entirely in our own modern plant. Peerless Electric is small enough to study your needs and special applications intimately—large enough to supply your complete requirements.

Write us for details on any standard Peerless Electric ventilating equipment, or tell us your special problems.

THE Peerless ELECTRIC COMPANY
WARREN, OHIO
Established 1893

shaft, or cable, and will ratchet continuously with only a 7½ deg movement of the handle, says the manufacturer. Construction is of alloy or tool steel. The wrenches are available in sets, consisting of the wrench and five sockets in the various sizes. They are available in five sizes with the following tube openings: ⅜, ½, ⅝, 13/16, and 1⅜ in.

Air Conditioned Crane Cab

No. 2942—A new type of crane cab (model "RPA") manufactured by the Cleveland Crane & Engineering Co., Wickliffe, Ohio, is equipped with an air conditioning unit with an air cooled condenser. The unit is intended for use where temperatures do not exceed 140 F and where radiant heat is not a factor.

It is designed to maintain a temperature of 85 F in the cab regardless of outside temperatures and introduces fresh air at the rate of once every 2 min. It also filters the air by both mechanical and activated carbon filters. In addition, it is equipped with an electric heater thermostatically controlled to maintain a temperature of 75 F during winter operation.

For major service requirements, the unit is detachable from the cab and can be lowered directly to the floor. Minor adjustments may be made from the access platform with the equipment in position.

The cab has a capacity of approximately 100 cu ft and receives 300 cfm of recirculated air and 50 cfm of new air, always maintaining an outward pressure. Pilot control of the unit is directly behind the operator.

An air diffuser is part of the cab design itself and is arranged to avoid drafts on the operator's head and

HAVE YOU INQUIRED HOW

THERMONICS

CAN IMPROVE, SIMPLIFY

YOUR PRODUCT, YOUR PLANT, YOUR POST-WAR PLANNING

*THERMONICS is the science of temperature control developed by Fenwal, Incorporated, by the direct process of determining the needs of industry and science for unerringly accurate thermal control of wide mutations.

Thermonics as a science in itself earns and deserves the attention of:

- all processes and production requiring regulation of extreme or moderate temperatures;
- makers of equipment requiring light weight, compact, efficient thermal regulation;
- makers and users of machinery, equipment, vehicles, wherein a safety factor of controlling or indicating excessive or dangerous mutations in temperature is essential.

THERMOSWITCH is the prime factor in Thermonics. THERMOSWITCH in its many types and adaptations, offers a lightweight, compact vibration-proof, highly sensitive yet rugged regulatory and detectory unit of almost unlimited utility.

Fenwal's data folder on Thermonics will prove of value to engineers. Your copy is ready for you.

Fenwal, Inc.
THERMOSWITCHES
FOR COMPLETE TEMPERATURE CONTROL
69 Pleasant Street, Ashland, Massachusetts

$1,000 PROTECTION WITH YARWAY IMPULSE TRAPS!

Clinton Woolen Manufacturing Co., at Clinton, Mich., knows the importance of using good steam traps. If a trap on one of their large carbonizers stopped operating, $1,000.00 worth of fine woolen material could be ruined before the fact were discovered.

With so much at stake, it was natural to standardize on Yarway Impulse Steam Traps . . . 50 are already in use, 22 more on order!

In other industries, too, Yarways are the leading trap choice. Already more than 400,000 have been sold. Here's why—

With Yarways, equipment gets hotter, sooner . . . and *stays* hot. *Continuous* discharge on heavy loads *gets* it hot—*intermittent* discharge on light loads *keeps* it hot, maintaining peak efficiency.

Yarways have only one moving part, a small heat-treated, stainless steel valve. They take little space, can be installed anywhere. Frequently new Yarways cost less than repairing old type traps.

See your local Mill Supply Dealer, or write for Bulletin T-1739.

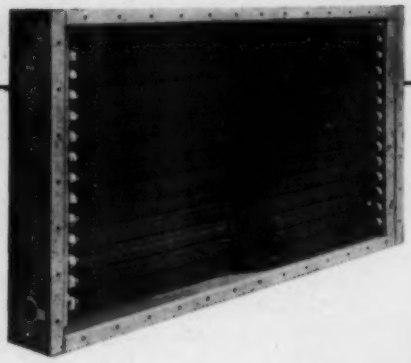
YARNALL-WARING COMPANY
107 Mermaid Ave., Phila. 18, Pa.

SEE YARWAY TRAPS . . . HEAR LOWELL THOMAS

describe their interesting design and application in the new 30-minute color and sound motion picture "There Is An Engineering Reason." Free for group showings. Write for details.

YARWAY IMPULSE STEAM TRAP

G&O RADIATION



G&O COILS

FOR HEATING AND COOLING IN A WIDE RANGE OF SIZES

Send for Catalog

THE G & O MANUFACTURING COMPANY
New Haven, Connecticut
Pioneer Manufacturers of Square Finned Tubing in the United States

shoulders. The air drops at low velocity around the front portion of the plastic panel and rises slowly about the operator.

Dew Point Recorder

No. 2943*—Close control of the effects of water vapor in air or other gaseous mixtures is claimed for a new dew point recorder now offered by Surface Combustion, 2375 Dorr St., Toledo 1, Ohio. It is said to be especially applicable for furnaces utilizing prepared gas atmospheres, or wherever dehydrated air or a gas mixture of controlled moisture content is desirable, as in the chemical and food processing industries, drug preparation, etc.

The recorder, having a temperature range of —70 F to 60 F, applies the principle of the dew point cup, which has long been used in its original form for determining the humidity of air and other gaseous mixtures. Its operation is therefore independent of the nature or composition of the gases making up the atmosphere. The presence of impurities in the furnace gases, such as hydrogen sulphide and sulphur dioxide, have no effect upon its accuracy. Hence an analysis of the furnace gas, previ-

THE new Airtherm Space Heater provides an even distribution of heat to all parts of the building through high velocity nozzles — is installed with a minimum of installation costs and requires practically no maintenance.

The new Airtherm Space Heater is available in 3 models — for floor mounting (as illustrated) or horizontal or vertical suspension. Choice of gas or oil burners on all models. Capacities from 650,000 to 1,950,000 BTU's per hour.

Write for bulletin describing this new, efficient, money-saving heater, in detail.

AIRTHERM
MANUFACTURING COMPANY
711 S. Spring Avenue • St. Louis 10, Missouri

now...on a wider range of motors

don't lubricate for 5 years or more

up to 15 hp

Induction motors—always an easy responsibility for maintenance crews—are now simpler than ever. Now, in sizes up to 15 hp, Westinghouse squirrel-cage motors need no lubrication for 5 years at least and maintenance is practically negligible.

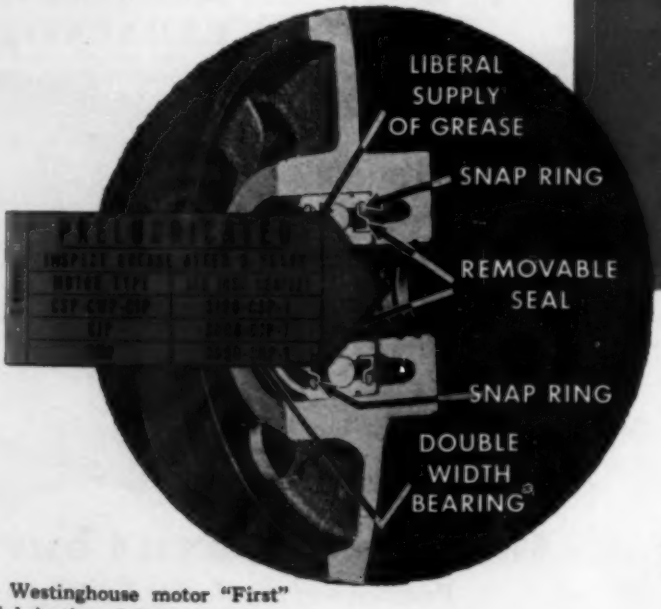
All Westinghouse squirrel-cage ball bearing motors (CSP and CS) up to 15 hp, frames 203 to 326, are prelubricated at the factory and sealed so they need not even be inspected for lubrication until after 5 years of 24-hour-a-day operation. In operations using many motors, this saves a large amount of time for maintenance crews and brings other advantages, as well:

- No overgreasing
- No "skipped" bearings
- No grease contamination
- No grease seepage
- No unreplaced pipe plugs

With all these advantages, you can install motors and work them hard for 5 years or more with no attention. For complete information, write for Bulletin B-3554 and Descriptive Bulletins 3100-CSP and 3100-1 to Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pa. J-21329

Type CS motor has prelubricated sealed ball bearings, frame sizes 254 to 325.

Type CSP motor has prelubricated sealed ball bearings, frame sizes 203 to 225.



Another Westinghouse motor "First" — the lubrication label that says "Don't lubricate for 5 years or more."

Westinghouse

PLANTS IN 25 CITIES . . . OFFICES EVERYWHERE

SQUIRREL-CAGE MOTORS

ously the customary method of checking for the desired humidity and often the only method used, is unnecessary.

The principal units of the recorder are a cup with a mirrored surface which can be refrigerated at varying temperatures, a thermocouple which is connected to a recording potentiometer, and the refrigerating unit with its associated circulating system. In operation a stream of the gas after filtering is directed against the mirrored surface of the cup, while refrigerant is circulated within the cup. As the temperature of the refrigerant drops, which in turn decreases the temperature of the mirror, a film forms on the surface when the dew point temperature of the gas is reached. As soon as the film forms upon the mirror, it intercepts a light beam which has been directed upon the mirror and which is reflected on a photo-electric cell. When this takes place the cell alters the flow of current which in turn shuts off the flow of refrigerant around the mirror, at the same time making an instantaneous point record of that temperature on the recorder chart. This operation is continuously repeated at 3 min intervals so that the series of instantaneous recordings forms a virtually continuous "line" for a 24 hr period, when a new chart sheet is mounted.

The refrigerating unit used in the recorder is of the small household type, mounted in the base of the housing. Above this on a separate shelf is the refrigerated dew point cup, light cell, etc., as well as the electronic tube amplifier for the thermocouple. The large potentiometer dial, calibrated in dew point temperatures, is mounted at the top behind a glass bezel which is easily

30% SAVING IN COSTS and a 500% increase in production are reported by this user of 16-Gage Electric "Porto-Shears."

Don't Snip . . . Add Zip

to Sheet Metal Cutting with Black & Decker Electric "PORTO-SHEARS"

Black & Decker Electric "Porto-Shears" zip through jobs that are slow with snips . . . cut metals too tough for snips . . . make clean, smooth, accurate cuts with a big saving of time and trouble. Fast, powerful shearing action. Cutting operation always visible. Easy to follow straight lines, irregular patterns or curves down to 3/4" radius.

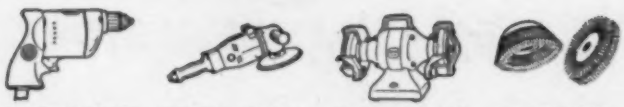
Two "Porto-Shears" models—16 and 18 gage—cut up to rated capacity in steel or galvanized iron . . . about one gage thinner in Monel or stainless . . . 50% above rating in copper, aluminum, lead and other non-ferrous metals. Operate on A. C. or D. C.

See your Black & Decker Distributor about "Porto-Shears" and other electric tools for sheet metal work, or write to: The Black & Decker Mfg. Co., 628 Pennsylvania Ave., Towson 4, Maryland.

LEADING DISTRIBUTORS EVERYWHERE SELL

Black & Decker

PORTABLE ELECTRIC TOOLS



ELECTRIC DRILLS ELECTRIC SANDERS BENCH GRINDERS WIRE BRUSHES

The General Says

ATTENTION

Write today for the complete information which General Blower Co. has prepared for you regarding

GENERAL MULTIBLADE EXHAUSTERS

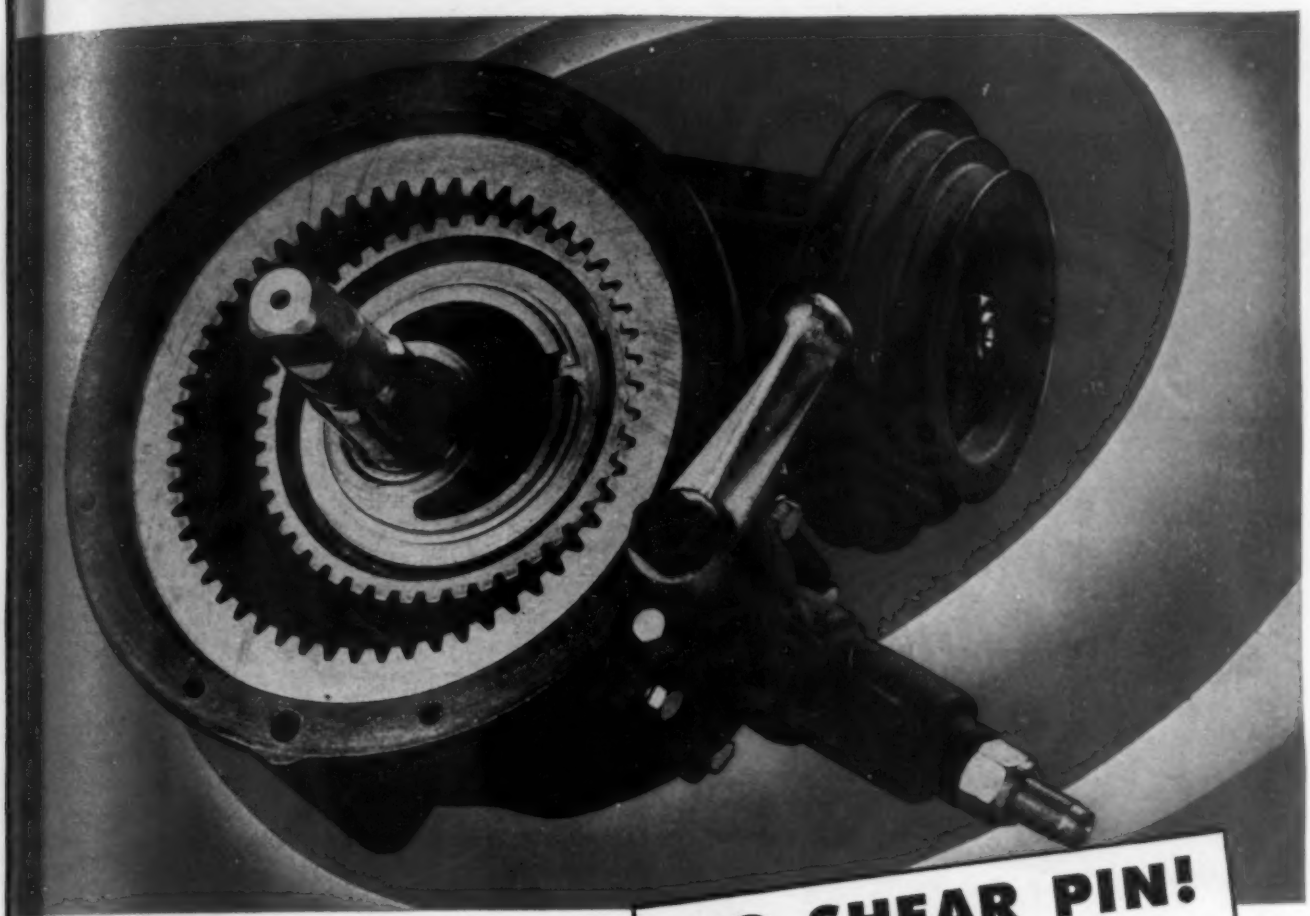
Ask for Portfolio SC-101—H.P.A.

DELIVERIES 2½ WEEKS

GENERAL BLOWER COMPANY

Producers of Air Moving Equipment

8606 Ferris Ave. Morton Grove, Ill.



Stoker-firing has long since proved its case as the low-cost way to burn fuel for either space heating or power. The question, therefore, among men responsible for economical heating plant operation is not *why* a stoker but *what* stoker! Obviously the savings made by a stoker hinge directly upon the *quality* of the equipment purchased.

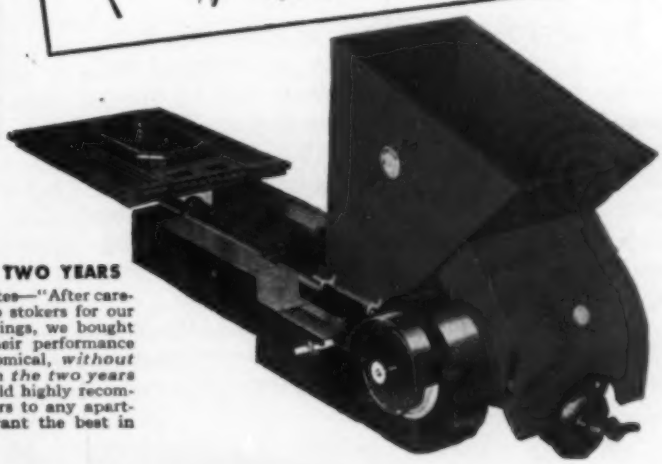
The creative engineering and high construction standards found in Winkler Stokers are a warranty of maximum fuel and labor savings plus protection of the investment itself. The Winkler Fully Automatic Transmission, for example, is a unit in which *Internal Planetary Gearing* eliminates the mechanical deficiencies of conventional gear designs. It develops *extra power* to overcome ordinary operating overloads. It is one of the reasons a Winkler Stoker can be depended upon for service-free operation and longer life.

A GOOD PRODUCT—A SOUND ORGANIZATION

Winkler's mechanical excellence develops to the fullest the multiple benefits of stoker firing. In addition, the purchaser of a Winkler Stoker has his investment protected in three ways. First—a nation-wide Distributor organization trained and equipped to give service under the close supervision of Winkler District Managers. Second—the backing of a company with excellent financial rating and complete manufacturing facilities. Third—a guarantee on the product itself.

NO SHEAR PIN!

When the screw load exceeds a predetermined torque the Winkler Automatic Safety Release disconnects the transmission from the drive shaft, then momentarily re-engages it. If the obstruction is rock or slate, two or three re-engagements will, in most cases, crush it. If the feed screw is permanently locked, the mechanism is fully protected even though it runs for hours. Upon removal of the obstruction, the Winkler resumes normal operation.



NO SERVICE IN TWO YEARS

A real estate man writes—"After careful investigation into stokers for our two apartment buildings, we bought Winkler Stokers. Their performance has been very economical, *without service attention in the two years of operation.* I would highly recommend Winkler Stokers to any apartment owners who want the best in heating service."

WINKLER

fully automatic STOKERS

U. S. MACHINE CORPORATION • Dept. H-11 • LEBANON, IND.

No manual cleaning necessary!
No interruptions in service!

PROBLEM: How to remove the sludge, oil, light lime, grease and boiler carryover which accumulates in every heating system—tearing down heating efficiency and skyrocketing fuel costs.

SOLUTION: The modern and scientific RID-SLUDGE method cleans traps and removes the sludge in all pipe lines, radiators and all other parts of the steam distribution system. There is no interruption in service, thus saving costly and precious man hours, materials and time. RID-SLUDGE likewise protects surfaces of your equipment against further trouble by keeping sludge on the move.

●*Write today for complete details of the RID-SLUDGE method. A national engineering service is maintained for your convenience.*

Apex All-Weather Products Co.
Engineering Division
128 NORTH LA SALLE STREET
CHICAGO 1 • ILLINOIS

opened for replacement of charts. Any conversion table can thus be utilized when desired to determine the per cent relative humidity from the recorded dew point. The sensitivity of the recorder can be adjusted by controls mounted through the front panel.

Cochrane Corp. Acquired by Employees

No. 2944—The Cochrane Corp., 3131 N. 17th St., Philadelphia 32, Pa., manufacturers of steam power plant and industrial equipment, has been acquired by a group of men long associated with the company in the engineering and sales division. The new corporation will be managed and operated by its owners. T. E. McBride was elected president and the following men were named as vice-presidents: C. E. Joos, apparatus division, V. A. Rohlin, works manager, A. E. Kittredge, chief engineer, and E. S. Daugherty, heater division. The board of directors includes H. E. Sibson, for many years the company's general sales manager, and W. V. Sauter. There will be no change in the company's line or sales policies, nor in its sales representation.

New Blower Wheel

No. 2945—Following an announcement of their new postwar blower, the Lau Blower Co., 2001 Home Ave., Dayton 7, Ohio, has recently indicated they will soon release details on a blower wheel which is claimed to be radically different from anything thus far placed on the market.

To meet an urgent need for increased production and warehouse facilities, the company is now engaged in an expansion program which "will practically double" the present manufacturing capacity.

HAYS COMBUSTION SET

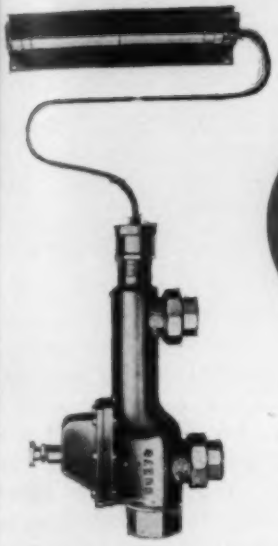
Portable
SIZE OF CASE
7⅛"x5"x15" HIGH
WEIGHT 9 LBS.

For accurate, quick combustion analysis. Combines single unit gas analyzer with a diaphragm type draft gage and flue gas thermometer. Completely enclosed in steel case with leather handle, weight 9 lbs. Of particular benefit to service and heating engineers and installers of oil and gas burners, stokers, furances, and boilers. Full details in Bulletin 43-362.

The HAYS CORPORATION
COMBUSTION INSTRUMENTS AND CONTROLS
MICHIGAN CITY, INDIANA, U.S.A.

HOME

L. D. Milligan residence, Lake Forest, Ill.

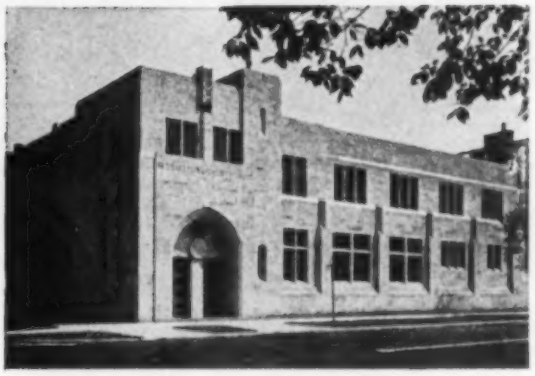


OFFICE

Radiant heating system, Greenville Steel and Foundry Co.

PUBLIC

Walther League Building, Chicago, Ill.



SARCOTHERM

WEATHER CONTROL

FOR RADIANT AND HOT WATER HEATING SYSTEMS

Now a Packaged Unit

Consisting of the control valve, outside thermostat, circulating pump, flow valve, thermometer and a strainer to protect the control valve.

JOBBERS—write for complete information on the packaged unit Sarcotherm.

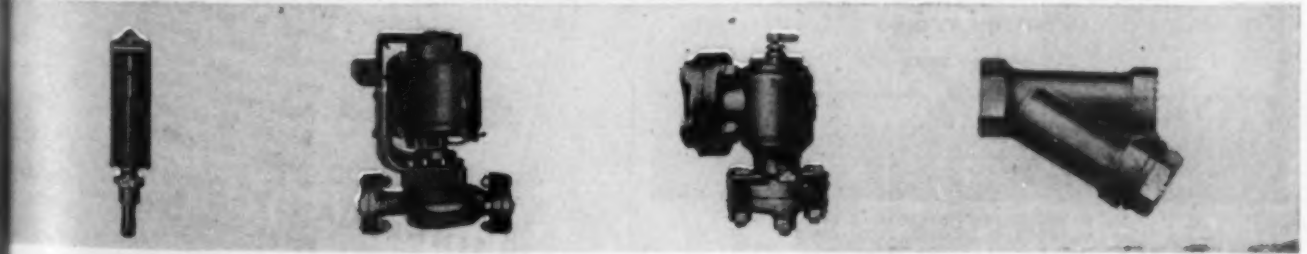
Sarcotherm is a new name in hot water heating control. For the first time, a simple, all mechanical and thoroughly reliable modulated weather control is available at a cost that is reasonable for small buildings and that helps get contracts for heating in large buildings and institutions.

It's a case where the best costs less, for Sarcotherm anticipates temperature changes and modulates with constant circulation. No cold seventies, no overheating in mild weather. Radiator temperatures are low, boiler temperatures higher and constant. No "on and off." Savings in fuel are as much as 25%. Smaller radiators and pipes reduce original cost. It is also the ideal control for Radiant Heat.

Sarcotherm is new — in its range of opportunities and old in principle and practice. It is an adaptation of the well known three way valve known as the Sarco Water Blender. It's your chance to introduce new, better and lower cost hot water heating without experimentation. Ask for the bulletin.

THERMORAY
for Radiant Heating

SARCOTHERM CONTROLS, INC., 280 Madison Avenue, NEW YORK 16, N. Y.



There's a certain thrill in trying to beat the shell game. And if you lose, at least you have been entertained.

But it's not entertainment, it's business when you shop around for low-priced plumbing supplies. And it's no fun to find that you have bought a pile of headaches.

Why take those risks when a reputable plumbing and heating jobber is just around the corner? Patronize him and let him supply you with trademarked, quality merchandise.

KUHNS BROTHERS CO.
DAYTON 7, OHIO

K
CAST FITTINGS

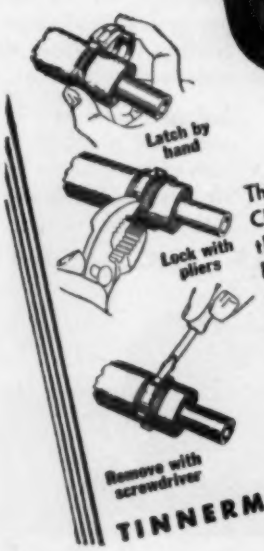
"K" fittings are carried in stock at Malleable Iron Fittings Co., Branford, Conn.; M.I.F. stocks at Kuhns Bros. Co., Dayton, Ohio.

Trackless Trolley Air Conditioned

No. 2946—The Carrier Corp., 302 S. Geddes St., Syracuse, N. Y., has recently announced that the world's first air conditioned trackless trolley has made transportation history since it was put into operation in Atlanta. Shown here is a side-view of the car, into which was built specially designed air conditioning equipment. A far cry from the old streetcar, this trolley has a cooling unit installed on the roof, while refrigeration equipment is under the floor. Heating

equipment for maintaining comfortable conditions in the winter is also included in the installation. A survey by the Georgia Power Co., operators of the air conditioned trolley, covering the first 10,000 riders showed that 94 per cent of them said that air conditioning increased the comfort greatly, five per cent said it increased comfort a little bit, and less than one per cent found no increased comfort. Another fact of interest is that 53 per cent of riders who have automobiles said that if all trolleys were air conditioned they would ride more often. The vehicle was built at the Worcester, Mass., plant of the Pullman Standard Mfg. Co.

THE *New* TINNERMAN HOSE CLAMP



This one-piece, ratchet type Hose Clamp is easily latched by hand, then quickly locked with pliers. Removed by prying locking tongue out of ratchet teeth with screwdriver. It weighs less, has a lower profile, exerts uniform pressure, and may be used over and over again. Approved by Army and Navy Air Forces. Sizes from ½" O.D. up. Write for details.

TINNERMAN PRODUCTS, INC.
2018 Fulton Road, Cleveland 13, Ohio

Year 'round hot water—a plus value!

Who, in this day of modern conveniences, can be content with anything less than a boundless supply of hot water. Every household task is made easier when piping hot water is always available . . . every little luxury of personal cleanliness can be enjoyed to the utmost. And remember—the new dish and clothes washers can't be operated on a mere trickle of hot water!

A B & G Hydro-Flo Heat System furnishes hot water for all household uses—24 hours a day, Winter, Summer, Fall and Spring—at so low a cost it can be used unsparingly.

What better recommendation of a heating system could you ask than the enthusiastic praise of its users? Williams-Harter Corporation, builders and developers at Port Washington, Long Island, N. Y., say this about B & G Hydro-Flo Heat (*Forced Hot Water*) Systems:

". . . our engineers made a very careful analysis of the house heating problem, finally concluding it would be best that we standardize on the hot water, motor circulated distribution system.

"We then elected to use Bell & Gossett circulating pumps and the other items of your manufacture necessary to complete this system.

"One hundred and seventy-five homesteads are using this equipment now and *in every case the utmost of satisfaction has been reported!* Each home owner tells us of his heating comfort and economical operation—your equipment goes along so quietly, too.

"We therefore felt you would like to know about these results here—*the service-free benefit of this working equipment to any builder is of extreme value.* This compliment is well earned by yourselves."

B & G Hydro-Flo Heat is winning equally enthusiastic comment from owners of apartments, commercial and industrial buildings. It is the system which matches the heat supply to the weather—at all times keeping indoor temperature at a constant, comfortable degree. Send for literature.

HYDRO-FLO HEAT IDEAL FOR RADIANT PANEL HEATING
Successful Radiant Heating depends upon the use of comparatively large heating surfaces at low temperatures. With the simplest kind of equipment, a B & G Hydro-Flo Heat (Forced Hot Water) System accurately maintains the temperature of the circulating water at the proper degree.
B & G

B & G Hydro-Flo Heat equipment can be installed on any hot water heating boiler.

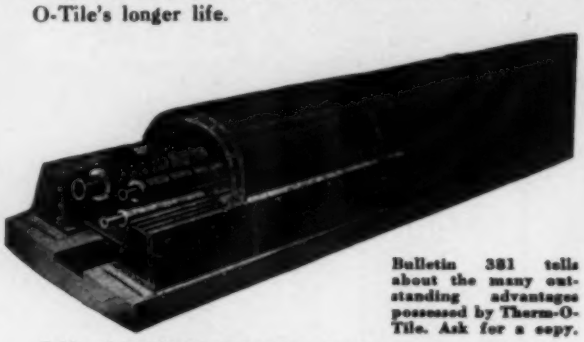
BELL & GOSSETT CO.
Dept. F-5, MORTON GROVE, ILL.

Hydro-Flo HEAT

FORCED HOT WATER HEATING FOR RADIATOR, CONVECTOR, UNIT HEATER AND RADIANT PANEL SYSTEMS

How much does the BEST obtainable Underground Pipe Conduit COST?

Don't be frightened into thinking that the first cost of Therm-O-Tile is high because of its assured *permanence*, greater efficiency, and superior strength. The first cost is nevertheless *competitive*. The final cost, of course, is the *lowest obtainable* due to Therm-O-Tile's longer life.



Bulletin 381 tells about the many outstanding advantages possessed by Therm-O-Tile. Ask for a copy.

Sold and installed by Johns-Manville Construction Units in all Principal Cities. See Sweet's Architectural File, or, The Heating Guide.

H. W. PORTER & CO., Inc.

822-H Frelinghuysen Ave. Newark 5, New Jersey

Manufacturers of

THERM-O-TILE

Reg. U. S. Pat. Off.

WPB . . . OPA . . . PAW . . . Etc.

Industry War Record Highlighted by WPB

Wartime accomplishments of the industries operating under the general industrial equipment division of the WPB were highlighted in a report issued recently. Some of the individual branches of the division reported as follows:

Commercial and Industrial Refrigeration Machinery

In the prewar period commercial refrigeration was mostly used in the preservation of food, and industrial refrigeration was used in cold storage and ice production. With the war program came the development of many new applications of refrigeration, such as low temperature wind tunnels, metal treating, test cabinets for instrument production, refrigerated tips on spot welders, and oil coolers for machinery.

The production of new products did not require new facilities, as it represented the application of existing equipment to new uses. All during the war commercial and industrial refrigeration was produced for essential civilian uses besides the war requirements. This represented complete equipment as well as repair parts. To conserve critical materials all existing equipment possible was kept running, and this was accomplished by licensing emergency service men who were allowed to extend high ratings for the purchase of

For **STOKERS**

The CROWN Unbreakable Coal Feed Screw

NOW AVAILABLE for Prompt Delivery

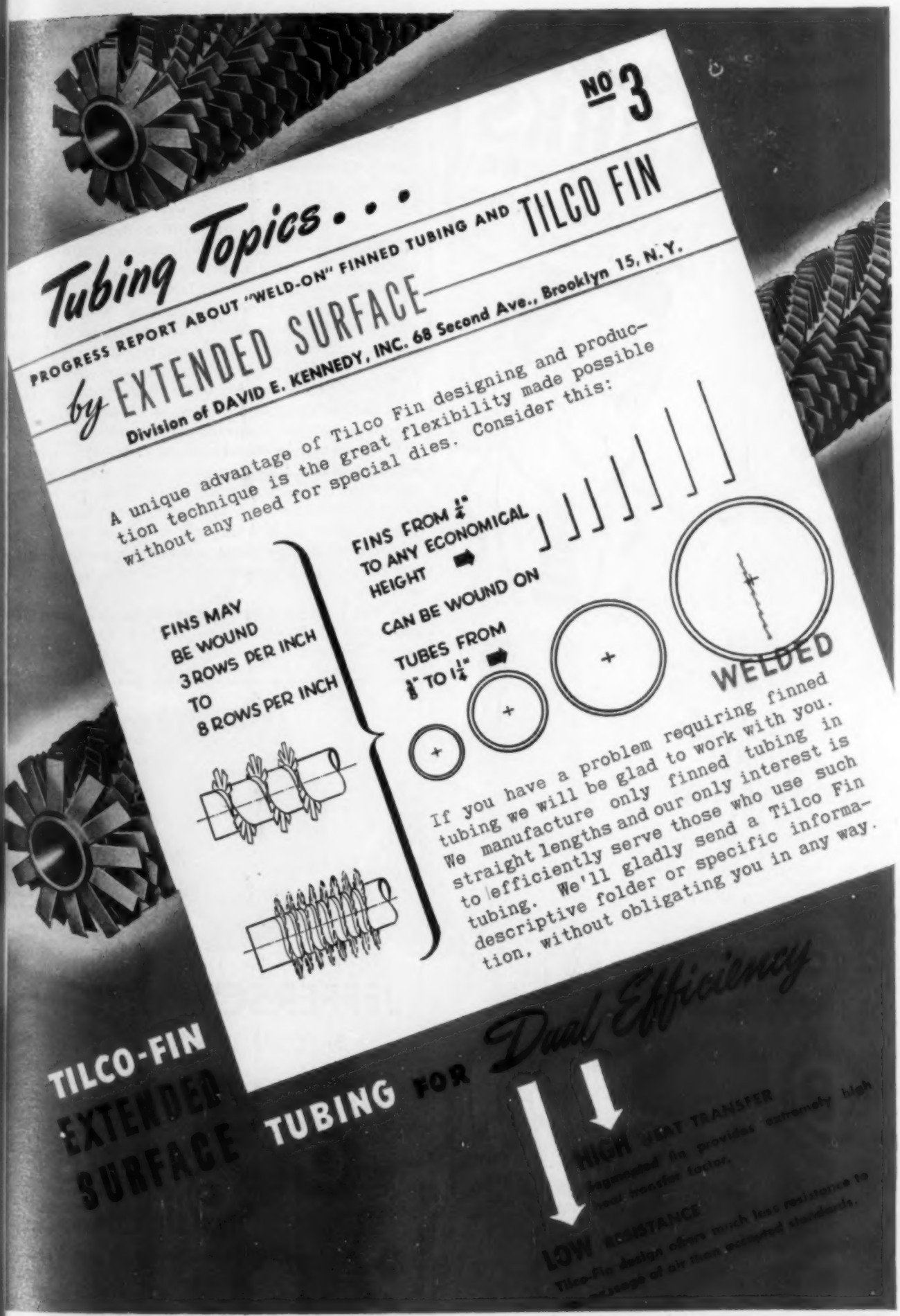
WELDED All-Steel Worm—All Sizes—All Pitches

★ Crown's complete line of all-steel Coal Feed Screws meets every replacement and production requirement. Produced for both domestic and industrial stokers. Crown Screws are available with right or left hand screws, in all sizes and pitches, tapered or straight, and in combinations of pitches. Uniformly smooth surfaces insure that coal will flow freely and easily through the flights. Because it is all-steel with continuous weld, the Crown Coal Feed Screw guarantees long, continuous operation with full customer satisfaction. Crown is in a position to make prompt delivery on all sizes.

In ordering give complete specifications on size and design.

CROWN IRON WORKS COMPANY

1268 Tyler St., N. E. *Since 1878* Minneapolis, Minn.


NO 3
Tubing Topics . . .
PROGRESS REPORT ABOUT "WELD-ON" FINNED TUBING AND TILCO FIN
by EXTENDED SURFACE
Division of DAVID E. KENNEDY, INC. 68 Second Ave., Brooklyn 15, N.Y.
A unique advantage of Tilco Fin designing and production technique is the great flexibility made possible without any need for special dies. Consider this:
FINS FROM 1/4" TO ANY ECONOMICAL HEIGHT
CAN BE WOUND ON
TUBES FROM 3/8" TO 1 1/4"
WELDED
FINS MAY BE WOUND 3 ROWS PER INCH TO 8 ROWS PER INCH
If you have a problem requiring finned tubing we will be glad to work with you. We manufacture only finned tubing in straight lengths and our only interest is to efficiently serve those who use such tubing. We'll gladly send a Tilco Fin descriptive folder or specific information, without obligating you in any way.
TILCO-FIN EXTENDED SURFACE TUBING FOR Dual Efficiency
HIGH HEAT TRANSFER
LOW RESISTANCE

BURKS Vertical Educer Deep Well System

Get Full Details on a BURKS' Dealership NOW

The loyalty of Decatur Pump Co. to its dealer organization, is a priceless advantage to every BURKS Dealer. It is not a loyalty of limited duration, but a relationship that has proven itself, in larger profits, to BURKS Dealers for many years.

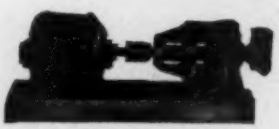
This close dealer cooperation — the completeness of the BURKS line—the outstanding quality of each BURKS Water System — the effectiveness of BURKS advertising and sales promotion — combine to make BURKS the most desirable dealership in any community.

Write us for complete details

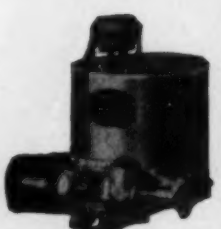
BURKS Turbine type Educer Deep Well System

DECATUR PUMP CO.

41 Elk St. Decatur 70, Ill.



BURKS Heavy Duty Super Turbine —Large Capacity Pressures up to 150 pounds



BURKS Condensation Return Units —both single and duplex types

repair parts. The industry put forth every effort to produce its share of the war requirements, which amounted to approximately $180,000,000 annually.

There are still products to be produced for the armed forces to maintain occupation forces as well as replace war damaged equipment. In order to accomplish this and supply civilian needs it has been necessary to add approximately $5,000,000 of new facilities. The construction of these facilities is well under way.

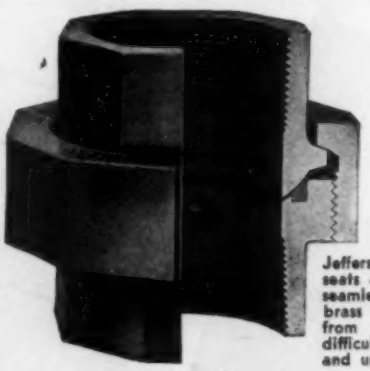
Electric Motors

Prewar production of electric motors was about $17,000,000 per month, consisting of industrial type motors in the integral horsepower sizes and domestic appliance type motors in the fractional horsepower sizes.

During the war period the large industrial types were needed for war facility use and in addition special navy, maritime, and army uses required high production of different designs. The domestic appliance fractionals were eliminated, being replaced with aircraft type motors radically different in all aspects, with different design and manufacturing problems.

In general, the motor industry did not convert to other products; it continued to build rotating electrical equipment. The equipment was much more difficult to build, however, and required nearly the same conversion effort as if a new product were made. There was very little new plant construction in the industry, but there was a great amount of retooling and plant revision.

In the fractional horsepower expansion a substantial share was in subcontractors' plants where complete subassemblies were made. Some essential civilian work



Jefferson Union seats are cut from seamless drawn brass tubing, free from all casting difficulties, sound and uniform!

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SAVE SPACE IN TIGHT SPOTS

Jefferson Unions are easy to work with . . . they save time, labor and space because they can be joined quickly and firmly in any area. A Jefferson Union is a permanent job. Use them always.

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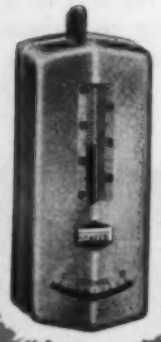
601 West 26th Street, New York 1, N. Y.

Factories at

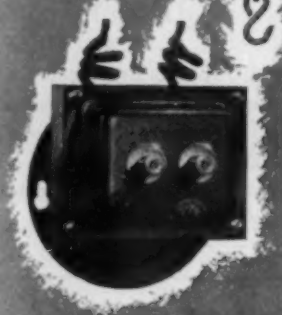
Lexington 73, Mass. **Lockport, N. Y.**

Regulators For Hand-Fired Heating Plants



THERMOSTAT

DAMPER MOTOR



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THESE INEXPENSIVE, EASILY INSTALLED UNITS

PLUS

MASTER "All Weather" CONTROL

... reduces heat loss up stack... prevents overheating in cold weather and holds fire in mild weather ... *Saves Fuel* ... brings added comfort, health and convenience.

BRING ADDED SATISFACTION

Write today for facts about MASTER "All Weather" CONTROL

PIONEER CONTROLS

The **MASTER ELECTRIC** Co.
Aircraft and Electrical Controls Division
DAYTON 1, OHIO

MASTER

was continued during the war on a replacement basis. It was found necessary to increase fractional horsepower a-c motor production to take care of this, since with the cutoff of all consumer goods there were not adequate facilities to provide motors for replacement purposes.

The industry expanded from a prewar output of $17,000,000 per month to a peak of $82,000,000 per month with a total of $934,000,000 in 1944 and $920,000,000 in 1943.

Fans and Blowers

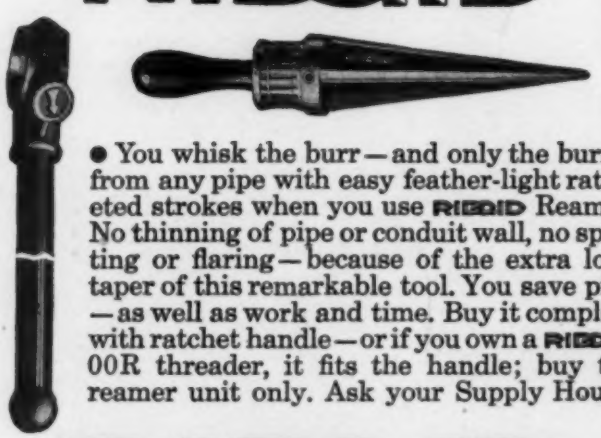
Throughout the war this industry successfully accomplished all of its required production and to a great extent attained its objective on its own initiative. By subcontracting and by close cooperation it was able to produce the required material very satisfactorily. The industry came from a prewar capacity of approximately $50,000,000 per year to a peak capacity of about $110,000,000 per year despite the fact that parts of the industry were engaged in the production of quantities of equipment entirely foreign to its normal product.

In several cases it was necessary to increase the manufacturing facilities. The industry as a whole has been equipped with approximately $1,500,000 worth of tools and new facilities, but a large portion of this expenditure was required for the production of special equipment. Some of these facilities have already been disposed of and some are not readily convertible to peacetime production. The production of the industry reached its peak in September 1944, with total shipments of $10,600,000 for that month.

FAST
EASY
Safe
PIPE REAMING

with this extra-long-taper

RIDGID



● You whisk the burr—and only the burr—from any pipe with easy feather-light ratcheted strokes when you use RIDGID Reamer. No thinning of pipe or conduit wall, no splitting or flaring—because of the extra long taper of this remarkable tool. You save pipe—as well as work and time. Buy it complete with ratchet handle—or if you own a RIDGID 00R threader, it fits the handle; buy the reamer unit only. Ask your Supply House.

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WORK-SAVER PIPE TOOLS
THE RIDGE TOOL COMPANY · ELYRIA, OHIO, U. S. A.

Difficult CLEANING PROBLEMS?

IN STEAM OR HOT WATER SYSTEMS

RID-AL Service

PROGRESSIVE ENGINEERS keep their heating plants operating continuously at top efficiency by taking advantage of RID-AL Service.

We exclusively offer this complete service which consists of three individual treatments for eliminating SLUDGE and all other foreign matter from your entire heating system.

RID-SLUDGE thoroughly cleans all pipe lines, traps, valves, etc.

BOYLOUT cleans the boiler itself.

PROTEX deposits a protective film thruout the heating system and retards further deposits. All of the above chemicals are neutrals, harmless to metals. Our methods are proven, safe and guaranteed to satisfy. The more difficult the job, the better we can serve you.

We offer you "CONSULTATION WITHOUT OBLIGATION" in solving your cleaning problems. Write us in detail your particular trouble. We solve the most difficult problems daily.

APEX ENGINEERING COMPANY
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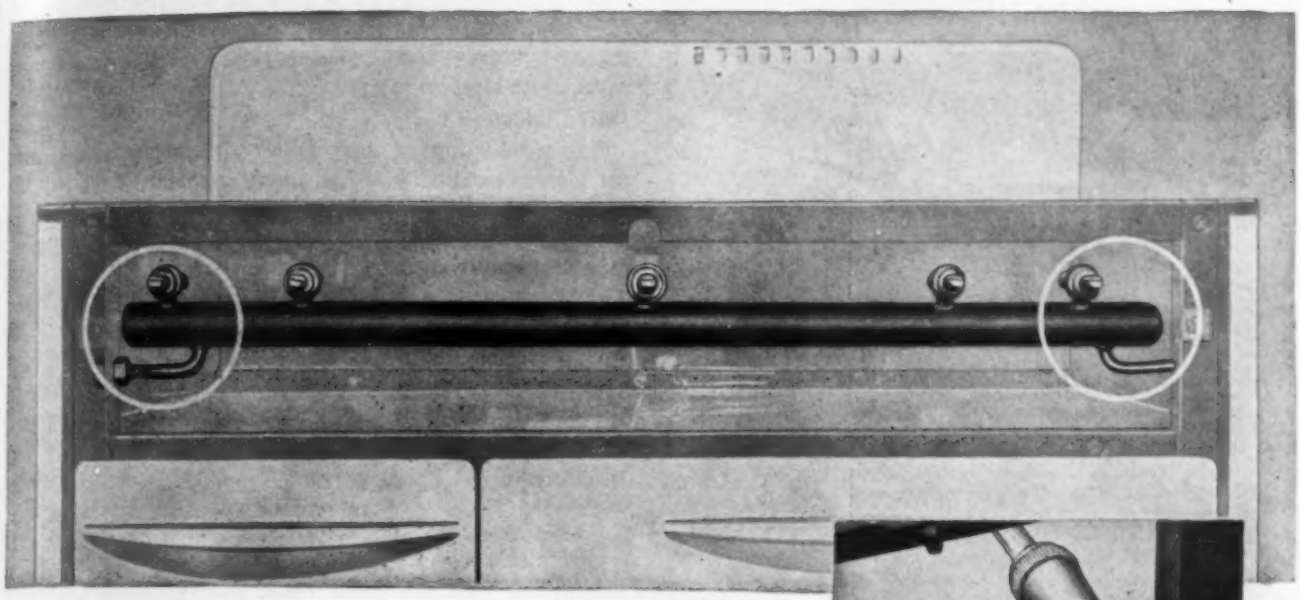
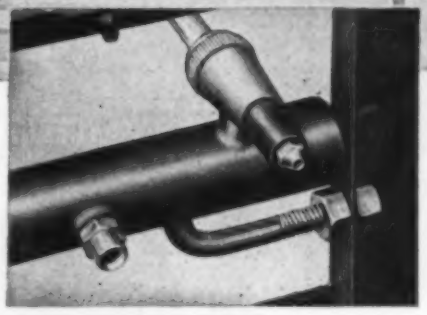
Chicago 6, Illinois

How stud welding helped produce a better stove...*faster!*



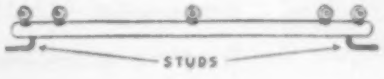


At right is a closeup of the complete assembly showing how stud supports the Feed Pipe.

This is the story of how a stove manufacturer used stud welding to save production time and cost — and obtain a better product

NELSON Stud Welding is a means of *automatically* end-welding studs. Flux-filled studs in all diameters from 3/16" to ¾" are welded in *less than one second*. The result is a stud completely fused to metal without distortion — equal in strength to studs secured by any other method.

Formerly cast iron was used for the Feed Pipe. Now a black-iron pipe is used because of the stud welding, resulting in faster production, and a better gas system with longer life for the pipe.



Straight studs were welded to the ¾" Dia. pipe and bent over after welding.

The studs are applied with the Nelson Stud Welding Gun, using a standard welding generator. The operator inserts the stud into the gun chuck, locates the pointed end in position and pulls the trigger. The stud is welded instantly to the metal. The ease and flexibility of the equipment permits an operator to weld 500 to 1000 studs per day. Precision production units of one or more guns are available.

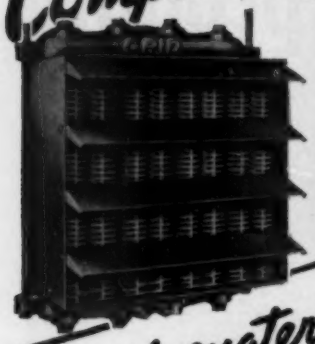
There are many similar problems that can be answered by stud welding. Write today for Catalog and Price List.

NELSON SPECIALTY WELDING EQUIPMENT CORP.

Dept. H, 440 Peralta Ave., San Leandro, Calif.

NELSON STUD WELDING

Compare the GRID UNIT HEATER WITH ANY ON THE MARKET TODAY— YOU'LL SEE WHY— IT LASTS FOR YEARS....



It's the material that makes the difference

• One piece construction heating sections (patented) of high test cast iron that withstand steam pressure up to 250 lbs.
• No soldered, brazed, welded or expanded connections to become loose or develop leaks.
• No electrolysis to cause corrosion, breakdowns, leaks, or heating failures.

GRID Unit Heaters are made to last, as is proven by the many and different types of plants that have operated them continuously — some for as long as 14 years, without maintenance expense.

Send for new free booklet "Corrosion in Unit Heaters", that tells you why cast-iron withstands corrosive atmospheres.

HIGH TEST CAST IRON HEATING SECTIONS

D. J. MURRAY MANUFACTURING CO.
WAUSAU • WISCONSIN

High Pressure Blowers

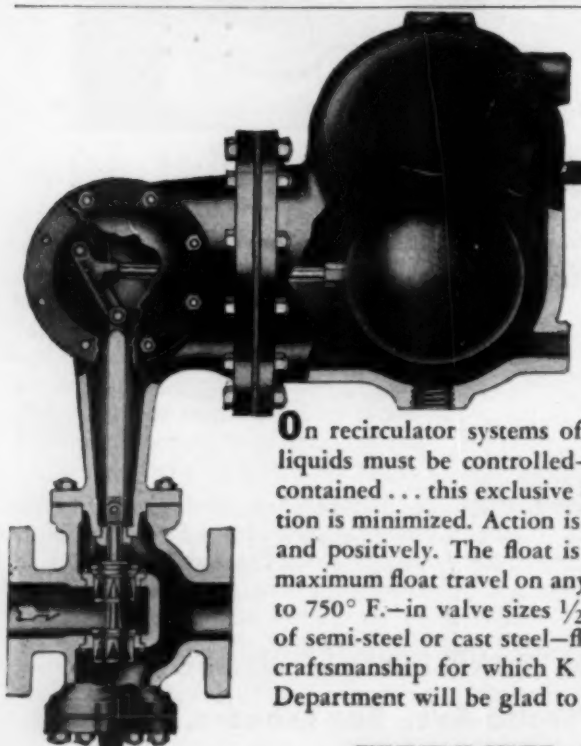
The production of high pressure blowers, rotary compressors and rotary vacuum pumps was materially increased to meet military requirements. The production of the industry was raised from a prewar level of approximately $20,000,000 per year to a capacity of about $36,000,000 per year. The facilities of the industry were increased by the expenditure of about $1,220,000. The peak in production was reached in May 1943 with total shipments of $3,500,000 for the month. A fair portion of the industry's production was represented by large blast furnace blowers required by the expanding steel industry.

Dust Collectors

The production of dust collectors, precipitators, and air filters was important in many respects, particularly to the chemical and rubber industries. Expansion in these industries and in certain types of aircraft engine capacity required greater production of dust collectors. The industry was equipped with approximately $1,100,000 worth of new facilities and the production capacity was increased from a prewar level of $25,000,000 per year to approximately $40,000,000 per year. Most of the new facilities were required for the quantity production of special units and for the production of other type products.

Air Compressors

The production of air compressors, especially in the larger sizes, was at one time quite critical. The total production was increased from a level of $95,000,000 per year to a maximum of $140,000,000 per year, with a peak of $14,300,000 per month. The total expansion of the industry was represented by the expenditure of



NO "GLAND TROUBLE"

because UNITROL Level Controller has no packing glands or stuffing box

On recirculator systems of condenser hotwells, deaerators—or wherever the level of liquids must be controlled—UNITROL will do it more accurately! Simple . . . self-contained . . . this exclusive design eliminates trouble-making restrictive elements. Friction is minimized. Action is free and unhampered. Feed or drain is regulated promptly and positively. The float is linked to the inner valve through ratio connection, with maximum float travel on any size valve of only 7 inches. Available for temperatures up to 750° F.—in valve sizes ½" to 4"—integral casting construction—valve and floatcage of semi-steel or cast steel—float of seamless copper or stainless steel—and with the fine craftsmanship for which K & M has been recognized for 75 years. Our Engineering Department will be glad to make specific recommendations.

Write for Catalog 66-C

KIELEY & MUELLER, INC.
MANUFACTURERS OF PRESSURE AND LEVEL CONTROLS
2015 43rd St., North Bergen, N. J.

Awarded our employees for outstanding production achievement

REASONS

why fans and blowers are *Quiet*

RANDALL ONE-PIECE STEEL HOUSING PILLOW BLOCK
Either Double or Single Oil Reservoir

FLANGE OR SIDE MOUNT PILLOW BLOCK
Double Oil Reservoir

UNIVERSAL PILLOW BLOCK
Double Oil Reservoir

Randall SELF-LUBRICATING, SELF-ALIGNING

PILLOW BLOCKS

AMERICA'S finest furnace blowers and air-conditioning units owe their quiet, dependable operation to Randall Pillow Blocks.

Over a third of a century of Randall experience in building graphite bearings—for war and peace—offers assurance of long, trouble-free service and freedom from maintenance troubles. The complete Randall line of self-lubricating, self-aligning pillow blocks provides a type that will dependably meet every air handling need!

Randall engineers can aid you in finding a quiet, dependable solution to your bearing problems! Write now for catalog 42. It is yours without obligation.

Representatives Carrying Stocks

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Tek Bearing Company
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Salt Lake Hardware Co.
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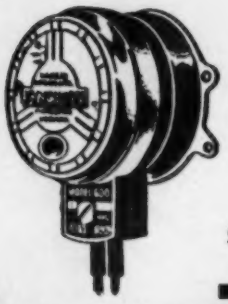
RANDALL GRAPHITE PRODUCTS CORPORATION
Dept. 1010 — 609 W. Lake Street — Chicago 6, Illinois

SYNCHRON

SYNCHRONOUS

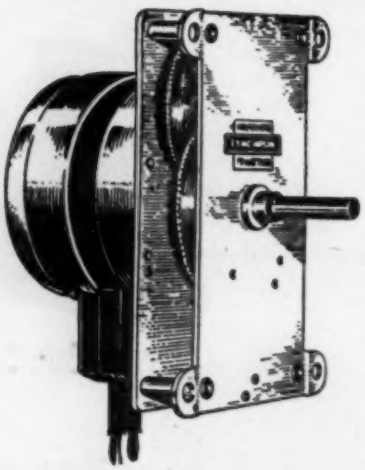


SELF-LUBRICATING

SELF-STARTING

TIMING MOTORS

AND



SYNCHRON-POWERED, PRECISION-BUILT

TIMING MACHINES

OUR fighting forces still demand the biggest part of our production of these miniature time-tested timing motors and time machines—but that does not interfere with our planning for your peace-time requirements.

If our standard models do not meet your particular specifications, our engineers will design new motors or gear-trains to do the job. Write today for engineering data.

HANSEN MANUFACTURING CO., INC.

PRINCETON 6, INDIANA

approximately $3,000,000 for facilities, many of which were required for the production of other items (such as small caliber shells).

Pumps

Pump production was of prime importance to the prosecution of the war and the capacity of the industry was raised from a prewar level of $100,000,000 per year to a maximum of approximately $500,000,000 per year. The expansion of the industry was accomplished by a relatively small increase in facilities and the bulk of it was obtained by supplementing existing facilities by subcontracting. There was no appreciable amount of conversion to other products.

Welding Equipment

The expansion of the welding industry as a whole was confined to the producers established prior to the war and for the most part these facilities will be maintained for the same type of production in the postwar period.

The production of electrodes was increased from 35 million pounds in 1940 to 100 million in the peak year of 1943. The production of oxyacetylene welding and cutting equipment was expanded from $8,000,000 in 1940 to approximately $32,000,000 in 1944. The production of arc welding machines was increased from $10,000,000 in 1940 to $41,000,000 in 1944. Only one new plant was added to the manufacture of resistance welding machines, and the production of this plant was for the most part confined to resistance welders for aluminum and magnesium. The production of this part of the industry was $3,000,000 in 1940 and increased to $17,000,000 in 1944.

EFFICIENT

ECONOMICAL

De Luxe type WK Pressure Actuated Water Regulating Valves for Freon, Sulphur or Methyl, are pilot operated, modulating. Standard adjustable opening range from 50 to 150 lbs. Factory set to open at 90 pounds. Precision engineering and individual testing for low cost, satisfactory performance. Available in sizes of ¼ to 2 inches FPT. Simple adjustment—easily serviced.

Other sizes and types are also available.

Electrimatic

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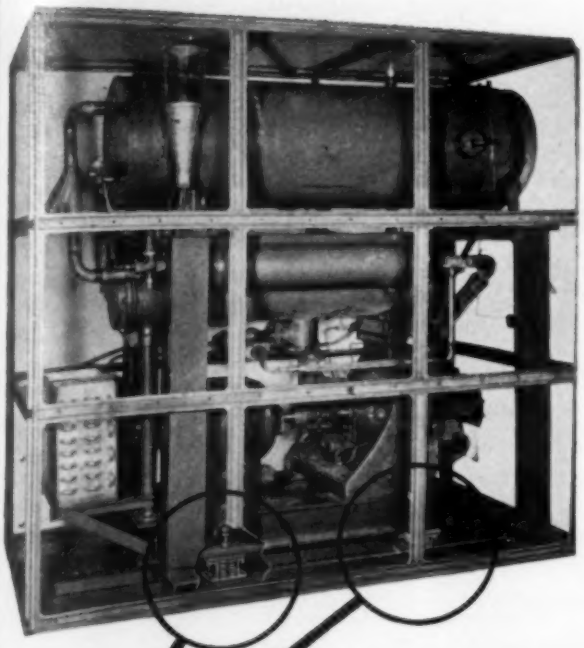


For Complete Comfort From Air Conditioning

ELIMINATE VIBRATION

On any air conditioning installation where noise and vibration are objectionable, there is a need for Korfund Vibration Control. This includes most installations, for even when noise is not a factor, vibration is the foe of efficient operation.

With Korfund isolated fans, compressors and motors, it is possible to operate air conditioning equipment in any part of a building without disturbing employees or customers.

Korfund engineers have had experience controlling vibration from all types of air conditioning equipment under widely varying conditions. Consult them on your own problems, without obligation.

KORFUND
VIBRATION CONTROL

THE KORFUND COMPANY, Inc., 35-33 33rd St., LONG ISLAND CITY 1, NEW YORK

"WHEN A JOB CALLS FOR MORE THAN ONE EVAPORATOR ON A SINGLE UNIT . . . .

I call for an A-P Model 235 Suction Pressure Valve — It's a good feeling to know what a valve can do . . . *and I know!*"

THAT is the comment from a Refrigeration Service Engineer when we asked him regarding his personal experience with "A-P" Valves.

Confidence like this is based on practical, day-in day-out experience in maintaining the nation's refrigerating machinery in spite of today's difficulties and handicaps. It is a trust shared by a widespread army of refrigeration service engineers who know that dependable "A-P" Controls, Valves, and Solenoids save them time-wasting call-backs — insure *customer satisfaction.*

A-P has cracked some hard nuts in the way of refrigeration servicing problems. Always feel free to consult us about yours!

AUTOMATIC PRODUCTS COMPANY

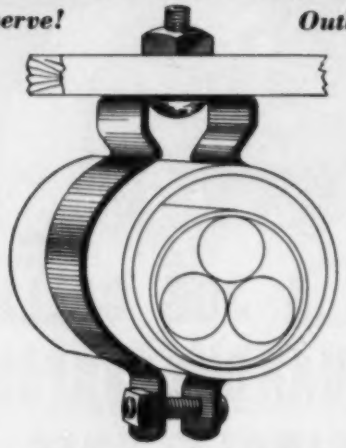
2460 N. Thirty-Second Street Milwaukee 10, Wisconsin
Export Department — 13 East 40th Street, New York 16, New York

A-P DEPENDABLE REFRIGERANT VALVES

MINERALLAC

Steel HANGERS, CLIPS, STRAPS

Outserve! *Outlast!*



MINERALLAC Cable, Conduit and Messenger Hangers are STEEL. Easier, quicker to install; permit speedy, compact wiring; economical. Also in Everdur . . . Porcelain Insulating Bushings available.

Jiffy STEEL Clips (Pipe-clamp) require only one screw, nail or bolt; rib-strengthened; for hanging pipe, conduit, BX cable, mounting coils, etc. Millions in use.

Steel Straps for Messenger-cable services on outlet boxes; may be used in conjunction with hangers.

Order from your Electrical Wholesaler. Send for literature.

MINERALLAC ELECTRIC COMPANY

25 NORTH PEORIA STREET CHICAGO 7, ILLINOIS

Power Transmission Equipment

As treated in the WPB organization, this industry included a varied group of manufacturers producing all types of conveyors and power transmission equipment, such as lineshaft drives, couplings, chain drives, gears, and speed changers. Also included were manufacturers of industrial wire cloth and perforated metal. These manufacturers did not form a clearly defined industry, but were grouped together for administrative reasons.

The war created a greatly increased demand for the industry's normal products, and production was increased by more intensive use of available facilities. Many of the manufacturers did subcontract work in addition to their normal products, but production of conveyors and mechanical power transmission equipment was doubled and tripled during the war years. The production peak was reached in December 1943, when the monthly output of the entire industry was estimated at $34,250,000.

Direct WPB Controls Over Construction Revoked

Revocation of construction order L-41 by the WPB became effective October 15. This action followed the statement issued on September 18 by WPB Chairman J. A. Krug and John W. Snyder, director of war mobilization and reconversion, that WPB would remove its wartime controls on construction.

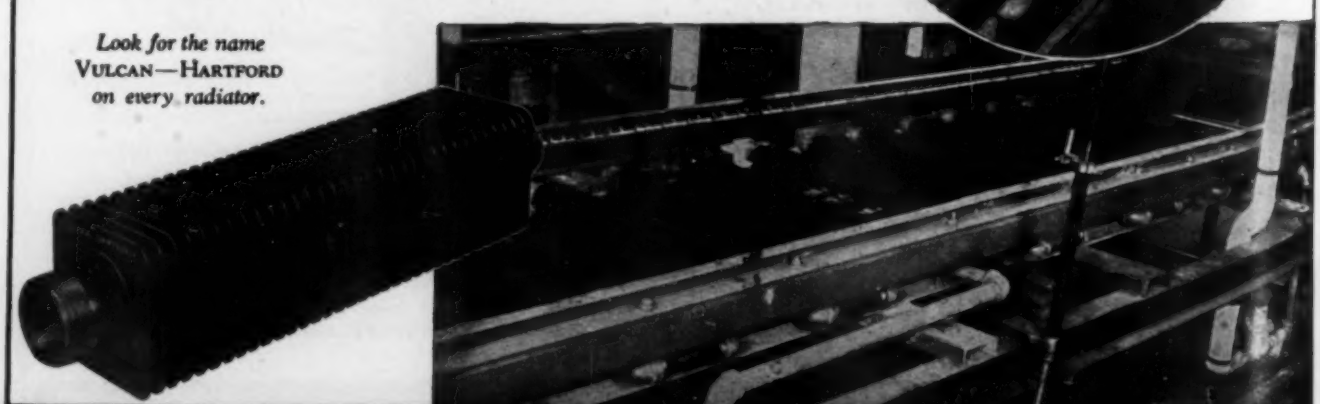
Also revoked were preference rating orders affecting construction (the P-19 and P-55 series) and directive 24, which delegated authority to the NHA to authorize housing construction.

Convert to "VULCAN"

for more HEAT . . . faster DRYING

The section of Vulcan radiation shown below is equal in heat output to that of 5 pipes of the same length and diameter. That is why industries are converting their drying equipment to "Vulcan" fin type radiation. Greater heat output can increase production by circulatory drying. High pressure steam may be used with safety. Sections cut to exact length . . . ends threaded or chamfered. Catalog No. 25 with all engineering data on request. Representatives in principal cities.

Look for the name VULCAN—HARTFORD *on every radiator.*



THE VULCAN RADIATOR CO. 26 FRANCIS AVENUE, HARTFORD 6, CONN.

RADIATOR MANUFACTURERS FOR OVER TWO DECADES

COMPLETE SALES PROMOTIONAL PROGRAM

—makes it easier to Sell LINK-BELT COAL STOKERS

Above: Link-Belt "Challenger" 30-50 lbs. per hour coal feed capacity, Bituminous Bin-Fed Model. Link-Belt builds both Bituminous and Anthracite Stokers.

Stoker selling is easier and more profitable when the dealer and salesman have attractive and informative literature to leave with prospects, enclose with surveys and send to lists. Link-Belt has the sales helps to fulfill the dealers' needs. Investigate!

Here are just two of the many pieces of literature available.

A COMPLETE LINE UP TO 1200 LBS. PER HOUR COAL FEED CAPACITY

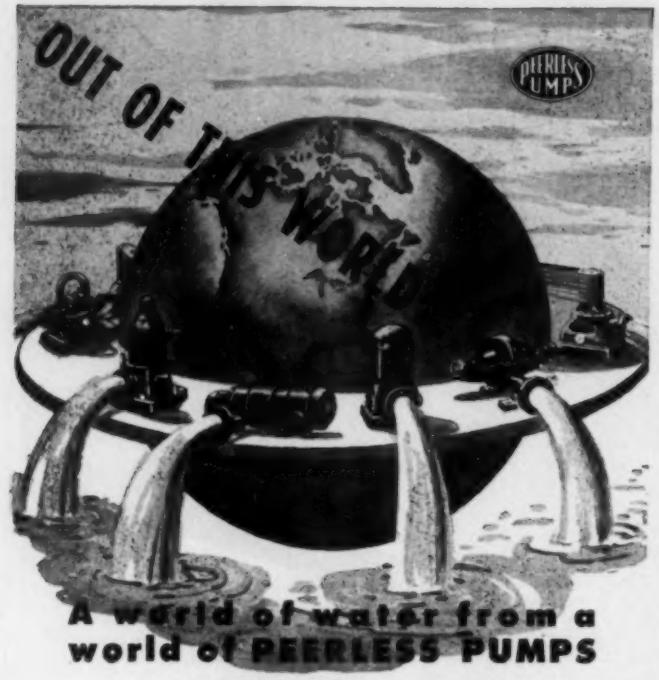
AUTHORIZED LINK-BELT STOKER DISTRIBUTOR

LINK-BELT COMPANY *Stoker Division,* 2410 W. 18th St., Chicago 8, Ill. 10096

I am interested in the Link-Belt Stoker Sales Franchise

NAME_____ FIRM_____

ADDRESS_____ CITY_____ STATE_____



5 to 220,000 gallons per minute
Distributors in all principal cities

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Food Machinery Corp.
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FACTORIES
LOS ANGELES 31, CALIFORNIA
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QUINCY, ILL. • CANTON 6, OHIO

WPB Forecast Shows 1946 Construction Up

A construction report based on studies made by the construction research branch of the WPB forecasts that total new construction in 1946 is expected to reach approximately $6,500,000,000, a 44 per cent rise from the 1945 level. The report, issued September 12, indicates that the bulk of the overall increase will be privately financed activity amounting to an estimated $4,350,000,000, an increase of 73 per cent over 1945 and a half billion more than was spent in 1939.

ASTM Meetings to Be Held In Buffalo and Pittsburgh

The executive committee of the American Society for Testing Materials has confirmed an earlier decision to hold the forty-ninth annual meeting of the society in Buffalo from June 24 to 28, 1946, and in conjunction therewith to have the seventh exhibit of testing apparatus and related equipment.

The 1946 spring meeting of the society will be held in Pittsburgh during the week of February 25 to March 1. This week will also be ASTM committee week, during which there will be many meetings of technical committees.

W. N. Findley, assistant professor of theoretical and applied mechanics, University of Illinois, has been awarded the 1945 ASTM Charles B. Dudley medal for his paper on Creep Characteristics of Plastics. An article, Air Conditioning a Tool of the Testing Engineer, by Mr. Findley, was published in the August 1943 HPAC.

50,000 to 10,000,000 B.t.u. with WECO-N.G.E. Series F600

GAS BURNERS. For use in heating boilers, power boilers—in any metal firebox or sectional boiler.

Adaptable to any firebox shape or size.

Handles various gas pressures and effects low draft loss.

The Series F600 Burner operates on straight natural gas and mixed gas to 800 B.t.u. Gives perfect horizontal distribution. Full automatic controls—that operate properly—can be easily applied. *Write for F600 Bulletin.*

THE WEBSTER ENGINEERING CO.

TULSA —DIVISION OF— OKLAHOMA

Surface Combustion . . . . . Toledo, Ohio

the Answer
TO MANY
NEW PRODUCT
DEVELOPMENT
PROBLEMS

HUSSEY

FOR YOU—charged with the responsibility of designing new or redesigning old products for consumer or industrial markets—Hussey Copper holds many important opportunities towards greater sal-ability, economy and dependability.

If your planned products require a metal that has exceptional electrical and thermal conductivity, malleability, strength, easy workability, high resistance to corrosion and rust-free—*only* Copper of all commercial metal combines *all* of these important properties.

Hussey engineers are available now, for constructive aid in planning for the most satisfactory and economical use of Hussey Copper.

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ROLLING MILLS and GENERAL OFFICES: PITTSBURGH, PA.
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BOSSES of the Btu

. . . the insulation experts' skill is your protection against the pitfalls of a poorly applied job.

CORRECT APPLICATION and lasting efficiency of refrigeration insulation are assured by the "Bosses of the Btu". . . men from Johns-Manville's construction forces or J-M Technical Service Units (contractors selected for their records in this field).

And . . . in addition to their skill in application . . . these insulation experts, like leading refrigerating engineers, specify and use Johns-Manville Rock Cork because of its many advantages in refrigerated service. Here are a few of the more essential features:

HIGH MOISTURE RESISTANCE—Made of mineral wool, with a waterproof asphaltic binder, Rock Cork is sealed against air and moisture infiltration . . . the cause of most insulation failure. Joints remain tight.

LOW CONDUCTIVITY—Rock Cork's rating is less than 0.33 Btu per sq. ft. per degree F. temp. difference per inch thick, per hour at mean temp. below 100° F.

RESISTANCE TO VERMIN AND BACTERIA—Completely sanitary, Rock Cork is odorless, can't absorb odors, harbor vermin, or support growth of mold and bacteria.

Remember an insulation's performance is only as good as its application!

For details write for brochure DS-555. Johns-Manville, 22 East 40th Street, New York 16, N. Y.

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ROCK CORK

RECENT TRADE LITERATURE

For your convenience in obtaining copies of these bulletins, see coupon on page 261. If you write direct to the manufacturer, describe carefully what literature you want, as the number given first in each item is for use only when sending in your request to Heating, Piping & Air Conditioning.

Air Conditioning Units

No. 5068—Unit air conditioners and summer and winter conditioning units are illustrated and described in a four page bulletin (The Producers' Council—No. 48), which is available from the Airtemp Div., Chrysler Corp., 1119 Leo St., Dayton 1, Ohio.

Air Filters

No. 5069—The applications of "Fiberglas Dust-Stop" air filters in central heating, air conditioning, and ventilating systems are described in a 24 page manual issued by the Owens-Corning Fiberglas Corp., Nicholas Bldg., Toledo 1, Ohio. Efficiency data are presented in tabular form, and installation and maintenance is thoroughly covered with text, photographs, and dimensional drawings.

Air Recovery

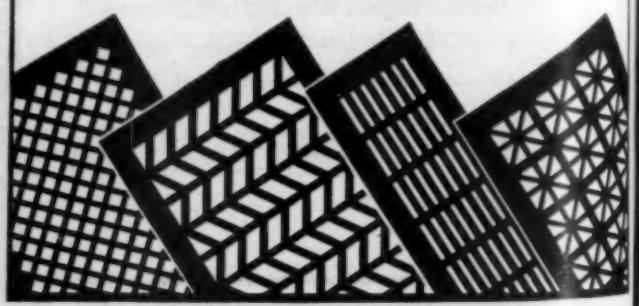
No. 5070—A 12 page folder, standard file size, has been published by the W. B. Connor Engineering Corp., 114 E. 32nd St., New York 14, N. Y., which contains a

Send for this FREE BOOK *on*

AUER GRILLES

AUER makes a wide line of attractive grille designs in stamped metals for all purposes, from which heating contractors can make selections appropriate to any surroundings. Practically any desired sizes in materials now available, can be furnished to fit your requirements for air conditioning, ventilating, radiator enclosure, or concealment. For choice of design and determination of sizes on grilles, keep this Auer Grille Catalog "G" handy. It gives complete grille data with actual size details. A copy will come to you on request. Complete Register Book also sent if desired.

THE AUER REGISTER COMPANY
3618 PAYNE AVE., CLEVELAND 14, O.



"We've sold 16 Johnson Burners since V-J Day

on replacements and conversions alone"

"... and the *new* building program hasn't even started rolling yet. When all those new houses begin going up (our town needs 600) we're going to put Johnson Burners in a lot of them.

"Already we are pretty happy about taking on the Johnson franchise. Looks like the smartest move our firm has made in fifteen years. Johnson Burners certainly have a backlog of good will which makes our selling job easier to do."

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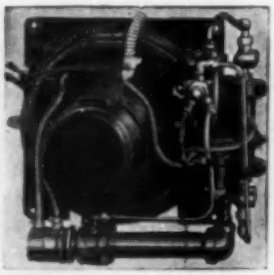
That "backlog" isn't just a lucky accident. We've put 42 years of single-minded effort into its building . . . 42 years of research and careful engineering and painstaking craftsmanship. It's an asset for our dealers all over America. It's one of the reasons why it might pay you to start selling Johnson Burners if there is a dealership open in your territory. We'll gladly let you know.



The Johnson Burner line is a *complete* line. Johnson dealers can fill *every* need . . . from a skyscraper to a 5-room cottage . . . with a burner *exactly right* for the job.

Johnson Oil Burners

Builders of fine Oil Burner Equipment since 1903

S. T. JOHNSON CO.
940 Arlington Ave., Oakland 8, Calif.
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Every heating man

SHOULD HAVE THIS

NEW CATALOG

fedders

Downblow UNIT HEATERS

FEDDERS MFG. CO. INC., BUFFALO 7, N. Y.

THIS new catalog gives complete working data on Fedders Series 12 Downblow Unit Heaters.

It is arranged to save time for every man who designs, sells or installs heating systems.

Fedders Series 12 Downblow Unit Heaters are used for high installations ranging from 15 to 45 feet above the working zone. Other uses include spot locations such as over frequently opened shipping room doors.

Capacities from 500 to 1800 EDR.

Look for Fedders in your classified telephone directory or write the factory for catalog 12 C-1.

FEDDERS MFG. CO., Heating Division
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Please send Series 12 Downblow Unit Heater Catalog.

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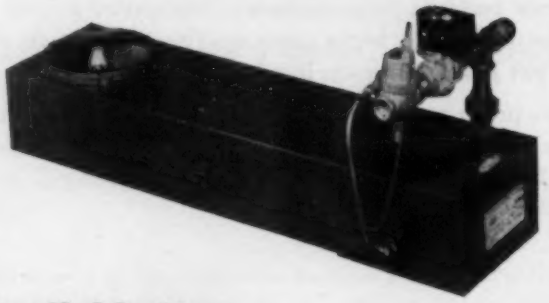
Concern .....

Address .....

John Zink

CONVERSION BURNER - - -



Available Now

Due to the scientific design of this unit the necessity of using conventional baffles has been eliminated, and efficiency has been increased over conventional types.

FEATURES

- Applicable to 98% of all domestic furnaces, for new installations or conversions.
- Converts Coal, Oil and Unsatisfactory Gas burners into GOOD HEAT PRODUCERS.
- Burns artificial and mixed gases as well as natural gas.
- LUMINOUS FLAME type.
- Can provide automatic heat at lowest equipment cost of any appliance on the market.
- Easily installed — Quickly inspected.

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Complete with Standard Pilot

Series P-300 burns 175 cu. ft. of gas per hr.	Series P-600 burns 400 cu. ft. of gas per hr.
$17.50	**$19.50**

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case history of the application of "Dorex" air recovery equipment to an existing system. There are also data on ventilation requirements and a typical cost chart on a new installation.

Arc Welding Electrodes

No. 5071—Recommendations for proper use of new additions to its line of arc welding electrodes are contained in a bulletin (L6348-A) of the Allis-Chalmers Mfg. Co., Milwaukee 1, Wis. Usage, contents, hardness, and welding procedure are given for chrome-moly hard facing and hard surfacing, nickel manganese, and mo-manganese welding rods, as well as for five types of stainless steel rods.

Bearing Material

No. 5072—The performance of "D-10," a low friction oilless bearing material, under high operating temperatures, is described in a four page bulletin of the Keystone Carbon Co., Inc., Saint Marys, Pa. A typical case is given in detail.

Boilers

No. 5073—The value of war production in terms of its relation to producing for peace is briefly surveyed in a four page folder released by the Fitzgibbons Boiler Co., Inc., 101 Park Ave., New York 17, N. Y. A map shows where the company's war products have been shipped.

Branch Pipe Outlets

No. 5074—A 16 page engineering data book (45) on branch pipe outlets with "WeldOlet" pipe fittings is

SHAPE BOOK
#6
The COMMERCIAL SHEARING AND STAMPING COMPANY
YOUNGSTOWN 1, OHIO
Requirements for circular stampings can be satisfied in many cases by using "COMMERCIAL" Standard Shapes—as listed in SHAPE BOOK" No. 6 . . . Write for a Copy

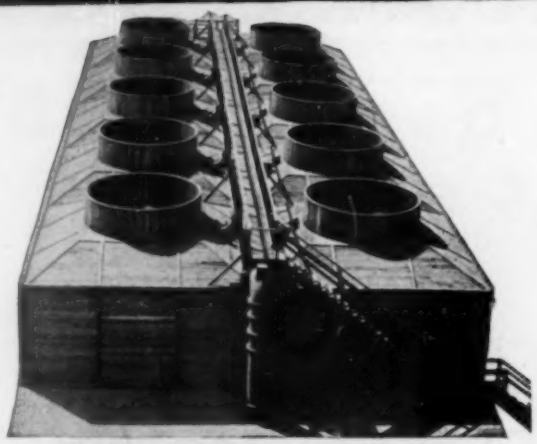
the **SOURCE** *of* **PRE-TESTED PERFORMANCE** *in* **COOLING TOWER DESIGN**

46 YEAR RECORD of L-H INSTALLATIONS

the **REASON**

"The proper coefficients for reducing (cooling tower) theory to practice are known by few . . . knowledge can be obtained only through long years of practice . . . observation of results produced by various installations . . . with varying atmospheric conditions . . . under different bases of efficiency."

Typical **APPLICATION**



Installed for War Department at large government arsenal for condenser water cooling.

Type: 10-cell Induced Draft Tower, back-to-back construction.

Construction Features: Independent operation of individual, or cell groups. Motors located out of air stream. Redwood discharge stacks prevent recirculation.

Capacity: 13000 GPM . . . 20 degree range.

NOTE: No leaks in tower casing . . . watertight wall construction. Photographed after 14 months operation.

Lilie-Hoffmann
COOLING TOWERS, INC.
Manufacturers of All Types of Water Cooling Towers
GENERAL OFFICE: 4239 DUNCAN AVENUE, ST. LOUIS, MO.
PLANTS AT ST LOUIS, MISSOURI AND PLAINVIEW, TEXAS

Better **THREADING WITH** *Less* **WORK**
with this direct-action, non-wobbling
RIDGID
No. 1R POSTER

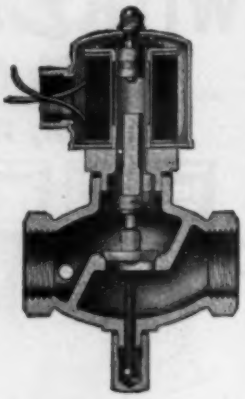
● You see its advantages the minute you compare this No. 1R with any other poster threader. The quick-set fool-proof workholder saves you time—and no bushings to bother with. Handle pulls head and dies directly—no indirect action over workholder—posts merely taper thread—no cockwobble, you thread faster with less effort, better threads. Alloy or high-speed steel chaser dies for 1" to 2" pipe. A rugged steel-and-malleable tool at popular price! If your Supply House is out of them, keep asking.

RIDGID
WORK-SAVER PIPE TOOLS
THE RIDGE TOOL COMPANY · ELYRIA, OHIO, U. S. A.

General Controls

K-3B MAGNETIC GAS VALVE

"THE VALVE WITH 101 USES"



Quiet, positive, trouble-free operation.

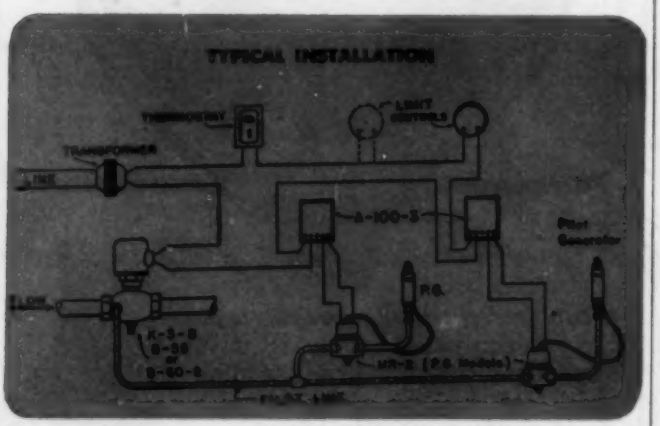
For operating pressures up to 5 pounds.

For all voltages and frequencies, A.C. or D.C.

For natural, manufactured or L.P. Gas.

Available in wide range of sizes, ⅜" to 6" I.P.S.

GENERAL CONTROLS K-3B is a versatile magnetic gas valve that delivers efficient, positive, continuous performance. It has earned universal acceptance for use in controlling gas to furnaces, boilers, heat-treating ovens, conversion burners and scores of other applications.



100% Shut-off for 2-Chamber Furnace

This typical K-3B installation will undoubtedly suggest many other gas control applications for this versatile valve. If you would like further information on what the K-3B, and other General Controls Magnetic Controls will do for you, write the nearest Factory Branch, Distributor, or direct to:

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FACTORY BRANCHES: PHILADELPHIA • ATLANTA • BOSTON • CHICAGO • DALLAS
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being distributed by the Bonney Forge & Tool Wks., Tilghman St. & Meadow St., Allentown, Pa. It contains specification charts, photographs, and dimensional drawings, as well as structural and application details.

Cellular Rubber

No. 5075—The Sponge Rubber Products Co., Derby Pl., Shelton, Conn., has published a four page pamphlet (84521), describing the various forms in which sponge rubber, bonded fiber, and other subdensity materials are manufactured. Illustrated are 98 molded, die cut, and fabricated shapes of flexible, elastic compressible products used for cushioning, vibration dampening, sealing, insulating, gasketing, etc.

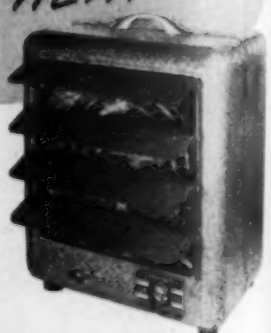
Centrifugal Pump

No. 5076—A two page sectional drawing in which each part is numbered and identified on an inset chart features a 12 page bulletin (51) on "Type G" self-priming centrifugal pumps published by the La Bour Co., Inc., 1301 Sterling Ave., Elkhart, Ind. Data on applications, installation, and operating are also included, as well as photographs, diagrams, and a schematic drawing illustrating the priming action of the pump.

Convectors

No. 5077—Convector heating is the subject of a four page bulletin (245) of the Modine Mfg. Co., 1772 Racine St., Racine, Wis. The "woman's viewpoint" on selecting heating equipment is given special attention.

For that Important EXTRA HEAT



IN
- Plant Offices
- Stock Rooms
- Warehouses
- First Aid Rooms
- Watchmen Shelters

and all other isolated or hard-to-heat locations.

BLOWER TYPE

CHROMALOX *Electric*

UNIT HEATERS

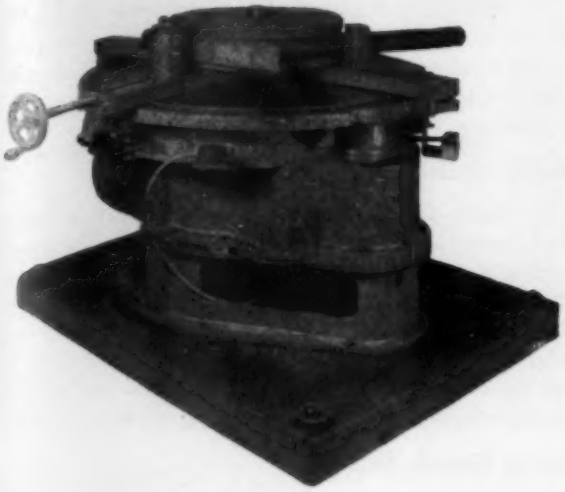
These ruggedly constructed CHROMALOX Unit Heaters meet the demands of industry for long, trouble-free life. Air is heated by sheath-encased CHROMALOX Koilstrips and forced through adjustable louvers by quiet, motor-driven fan. Automatic temperature control protects against overheating. 1.5 to 4 KW, 115 or 230 volts.

Write for catalog 42 and "100 Ways To Apply Electric Heat" booklet.

EDWIN L. WIEGAND CO.
7610 THOMAS BLVD. PITTSBURGH 8, PA.

CHROMALOX 19-11

ELECTRIC HEATING AT ITS BEST



The cheapest method of bending pipe is the one which gives the highest production at the lowest first cost. PEDRICK BENDERS qualify under both of these conditions. A Pedrick Production Bender will save you money because it can be run by inexperienced labor, is relay controlled, and fool-proof. Its production is high and its spoilage is low.

PEDRICK TOOL & MACHINE CO.

3640 N. Lawrence St. Philadelphia 40, Pa.

CONTROL ROOM TEMPERATURES INDIVIDUALLY . . . AUTOMATICALLY

With STERLING THERMOTROLS

Automatic Individual Radiator Control Protects Health . . . Conserves Fuel

The No. 120 Thermotrol is a simple self-contained radiator valve that controls the flow of steam or water to each radiator in accordance with individual room temperature requirements. The Thermotrol can be adjusted for any temperature from 55° to 85° F., and, once set, can be locked in position. The operation of the Thermotrol compensates for solar heat radiated through windows or skylights.

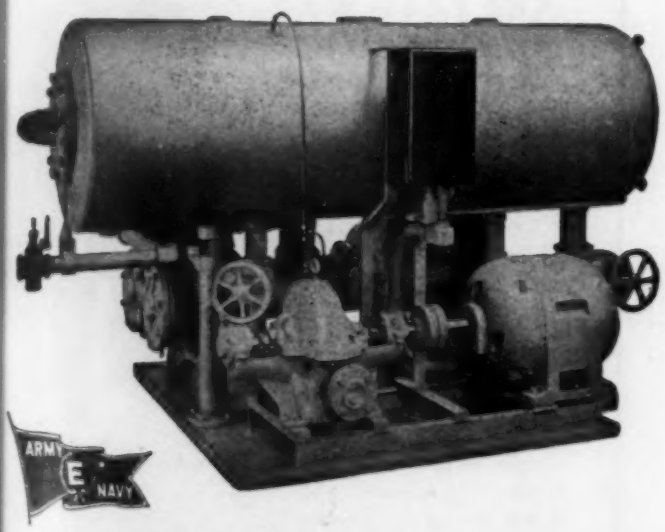
Overheating wastes fuel—each degree of heat not needed represents a 4% fuel loss. Sterling Thermotrols can reduce fuel costs as much as 25%. The Thermotrol can be installed on most two-pipe, steam, vapor, and hot water heating systems without additional piping or alterations.

Write for Bulletin No. 443.

STERLING, Inc. 3738 North Holton St. Milwaukee 12, Wis.

Heating Specialties — Temperature Controls — Heating Pumps
Sold by Plumbing and Heating Jobbers Everywhere

Boiler Feed Pumping Units



A star has been added to the "E" Award for Walter H. Eagan Company's high achievement in the production of Condensate Return Units.

- For use where boiler feed should be controlled by boiler water level.
- Where operation of boiler water make-up and condensate return is combined.
- In process steam installations where little condensate is returned.

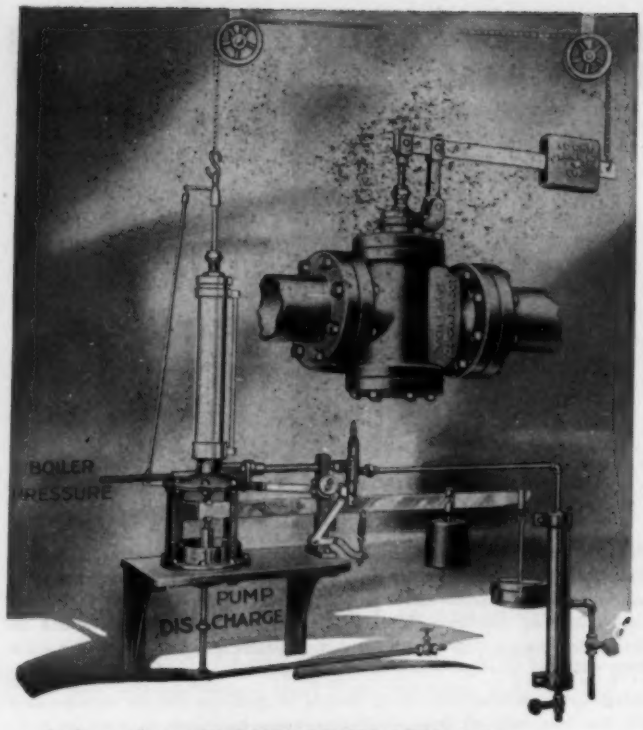
This is one of the various types of Condensate Return Units manufactured by Walter H. Eagan Co. No matter what your requirements, there is an Eagan Unit to do the job.

PUMPS

Write for General Catalog No. 2
Consult us on your requirements

WALTER H. EAGAN CO.

2336-38 FAIRMOUNT AVENUE, PHILADELPHIA, PA.



It's the DIFFERENTIAL That Makes the Difference!

Designed for very close regulation, this Locke Model 14 Excess Feed Line Pressure Regulator (hydraulic) has opposing chambers above and below the scale beam. Boiler pressure is connected to upper diaphragm chamber, and feed line pressure to lower diaphragm chamber. Weights on scale beam are balanced to secure desired differental between feed line and boiler pressure, which is constantly maintained.

—and these advantages make a difference in costs!

Water pressure operates the motor piston to control operation of dial switches or drum controllers to govern variable speed motor-driven pumps. When constant speed motor-driven pumps are used, this regulator governs a balanced regulating valve in either suction or discharge line at pumps, maintaining a constant excess pressure in feed line to boilers.

Its variable compensating device graduates all control movement to desired adjustment.

LOCKE ENGINEERS CAN ADVISE OF OTHER APPLICATIONS FOR THIS REGULATOR VALVE

Write us full details of your particular regulating problems and requirements.

DIVISION OF THE H. T. WILSON MACHINE CO., INC.

LOCKE REGULATOR COMPANY

WALTER AND OSBORNE STREETS
SALEM, MASSACHUSETTS

MODEL REGULATORS · DAMPER REGULATORS · FAN ENGINE REGULATORS · BACK PRESSURE VALVES · BALANCED VALVES · ELECTRIC VALVES · REDUCING CONTROLS FLOAT CONTROLS · PILOT CONTROLS · PUMP GOVERNORS · VACUUM BREAKERS ENGINE STOPS · MASTER REGULATORS · OIL CONTROL VALVES · SOLENOID CONTROLS

Cutting Torches

No. 5078—Hand and machine cutting torches and tips are the subjects of a 36 page booklet published by the Victor Equipment Co., 844 Folsom St., San Francisco 7, Calif. Operating data are given, and there are many illustrations, some in full color.

Diesel Control System

No. 5079—The "Type R-18" safety control system for the shutdown of diesel engines when temperature of the circulating water system becomes too high, or when there is insufficient lubricating oil pressure, is described in a four page data sheet (R-18) released by Viking Instruments, Inc., Stamford, Conn. It contains information on operation, with detail drawings of general arrangements and installation procedure.

Diesel Electric Sets

No. 5080—The applications of diesel electric sets are discussed in a 12 page booklet (9091) published by the Caterpillar Tractor Co., 600 W. Washington St., Peoria, Ill. Photographs show the sets in both single and multiple installations on many jobs, and the accompanying text tells briefly how power requirements were met in each case.

Fine Dust Collection

No. 5081—The problem of efficient fine dust collection, particularly in the range 325 mesh screen or finer, is discussed in a bulletin (101) of the Aerotec Co., White Plains, N. Y. Included are precipitating tests on various dusts in the industrial field. Also described are

FLEXAUST

THE EASY WAY TO VENTILATE CONFINED SPACES

3" TO 24" DIAM.

- **Light weight and very easy to handle.**
- **Extremely flexible.**
- **Will not support combustion.**
- **Easy to couple and attach.**
- **Also "Portovent" and "Bioflex" for uses requiring collapsibility.**

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THE NEW

★ Peerless ★

MERCHANDISING PLAN

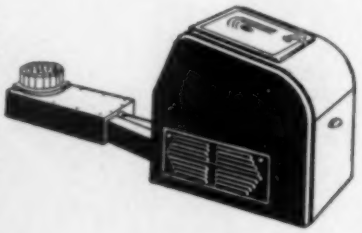
Distributor-Dealers, with an eye to successful promotion of Stoker Lines will be interested in the many aggressive features of this NEW PEERLESS MERCHANDISING PLAN, which is entirely too broad in scope to detail in this message.

You will be highly pleased with your Fire-Guard PROFITS resulting from the NEW PEERLESS MERCHANDISING PLAN, supported by sales aids aplenty, thorough technical information, fully protected and respected territories, plus fast selling attractively priced stoker.

While time-tested mechanical superiority is a prime requisite to the successful distribution of any device, quality must be combined with a MERCHANDISING PLAN attuned to post-war Distributor-Dealer requirements in order to prove profitable.

It has long been a proven fact... Peerless Fire-Guard Stokers have mechanical superiority — The King of them all.

For full and complete information write Clarence A. Rundall, Manager, regarding a Fire-Guard Stoker Distributorship. Very desirable territories are still open.



PEERLESS FIRE-GUARD STOKERS

Peerless

MANUFACTURING CORPORATION

INCORPORATED

LOUISVILLE, KENTUCKY

SINCE 1884

CUT AIR FILTER REPLACEMENT COSTS

with

RESEARCH AIR FILTERS

For Filter Banks and Industrial Dust Collection

STOP MORE DUST with RESEARCH AIR FILTERS! High dust removal efficiency comes from patented construction. The air is reversed 21 times in its journey through the Research Air Filter—impinging on more than 30,000 tiny baffles per square foot. LOW RESISTANCE TO AIR FLOW—surface clogging reduced to a minimum.

Write For This Study

"The Effect of Dirty Air Filters on the Performance of a Winter Air Conditioning Unit" — shows how clean air filters cut heating costs, increases air volume circulation. Sent free on request.

TECHNICAL DATA SHEETS on filters and filter banks are available. Write for copies.

RESEARCH PRODUCTS CORP., MADISON, WIS.

Factory owners
are asking about the
"Open Roof" Method of
Industrial Ventilation
Made possible by the Swartwout
AIRMOVER

Architects and ventilating engineers: you'll find it an advantage to know about "open roof" ventilation — the modern method of large scale air movement. It makes possible the solution of many ventilation problems heretofore only partially solved because of ventilator design and structural difficulties.

Unusual flexibility is an outstanding feature. Swartwout AIRMOVER can completely cover the roof if required, or can be spotted in units or runs at the exact location where needed. The ventilator is only 32 inches high—usually out of sight from the ground. AIRMOVER installations all over the country, on all types of buildings have proved in an outstanding manner the soundness of this Swartwout development. Write for full particulars.

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Imagine this view multiplied many times — to supply complete roof coverage.

Specialists in Air Movement
by *Natural* Methods

dust collector units in sizes from single tubes to 100,000 cfm. Copies will be sent on request to the Thermix Engineering Co., First National Bank Bldg., Greenwich, Conn.

Flexible Hose Assemblies

No. 5082—This 54 page bulletin is "an invitation to industry to get acquainted with the products, facilities, experience, and capacity" of the Aero-Coupling Corp., 1051 N. Hollywood Way, Burbank, Calif. It contains specifications, installation and operating data, and many photographs and diagrams of flexible hose couplings for aircraft, marine, automotive, industrial, and commercial applications.

Flow Measurement

No. 5083—The "Rotasleeve," a new "rotameter" for measuring large flows of liquids and gases, is described in a four page bulletin (82A) of the Fischer & Porter Co., 7344 County Line Rd., Hatboro, Pa. Photographs, diagrams, and capacity tables are included.

Forced Hot Water Heating

No. 5084—The application of forced hot water heating to radiant panels, as well as to other types of radiation, is described in a two page bulletin (The Producers' Council—No. 48) published by the Bell & Gossett Co., Morton Grove, Ill. Typical installations are illustrated.

Heat Exchange Equipment

No. 5085—A table of temperatures and gage pressures for ammonia, "Freon 12," methyl chloride, sulphur dioxide, and "Freon 22" is being distributed by

Why Speed Nuts are First with Production Men

NOTHING LOCKS LIKE A SPEED NUT
Only SPEED NUTS provide a COMPENSATING thread lock and a SELF-ENERGIZING spring lock. As the screw is tightened the two arched prongs move inward to lock against the root of the screw thread. These free-acting prongs COMPENSATE for tolerance variations. Compression of the arch in prongs and base creates a SELF-ENERGIZING spring lock. These two forces combine to definitely prevent vibration loosening.

Production men who use them will tell you that SPEED NUTS start easier, tighten down faster, and eliminate fumbling around with lock washers.

Production men also will tell you how much time is saved with all of the self-retaining types of SPEED NUTS that snap into bolt-receiving position by hand, and avoid welding or riveting cage nuts in place. Moreover, these self-retaining SPEED NUTS provide "float" to compensate for possible misalignment of holes.

Investigate the advantages SPEED NUTS might have for your own benefit by writing us today for further information.

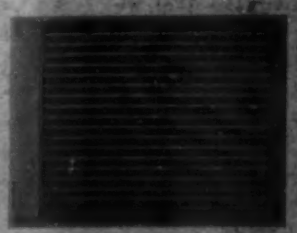
TINNERMAN PRODUCTS, INC. • 2038 Fulton Road, Cleveland 13, Ohio

Speed Nuts
PATENTED

FASTEST THING IN FASTENINGS...OVER 3000 SHAPES AND SIZES

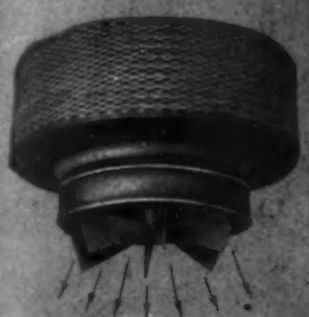
McCORD
HEATING AND AIR CONDITIONING PRODUCTS

BLAST HEATING COILS—AIR CONDITIONING COILS—ALL TYPES



All copper spiral fin tube construction with the tubes formed or bent permits uniform expansion without strain. Headers are heavy wall construction with tubes brazed into extended ferrules formed in the headers. Fins are helically wound and metallically bonded. May we send catalog?

VERTICAL TYPE UNIT HEATERS



A proven heating unit, modern in design, incorporating every unit heater advancement. McCord copper spiral fin tube construction creates air turbulence without undue restriction. Improved fan blades deliver large volume of air with minimum air noise. Guaranteed for 150 lbs. saturated steam pressure. Specify McCord.

HORIZONTAL TYPE UNIT HEATERS

A time proven heating unit, modern streamlined in design, quiet, yet its rugged construction adapts it to all types of installations, guaranteed for use on No. 150 p. s. i. steam pressure. All copper heating element, individual spiral fin tubes free to expand without strain on joints. Standard motors with standard bases used. Wide range of capacities.

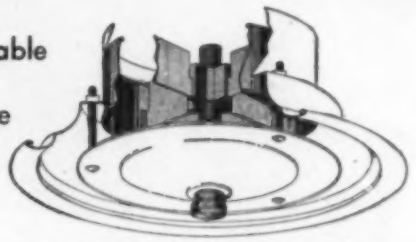
Save fuel with McCord Unit Heaters.

McCord CORPORATION
DETROIT 11, MICH.

Control of air direction and volume as an aid to satisfactory supply air diffusion

Whether they are used in heating, cooling, ventilating, or combined systems, KNO-DRAFT Diffusers can be adjusted quickly and accurately for system balancing and individual or seasonal requirements. As a result the factors of temperature variation, temperature fluctuation, drafts and noise can be minimized considerably.

Type K Adjustable Diffuser with Type D Volume Damper for supply air.



Pat. and pat. pending

Any desired condition at your fingertip.

Type SR Adjustable Diffuser for supply and return air.

By simply turning the air adjustment screws (easily accessible from under the unit) the inner cone may be raised or lowered to secure any angle of air direction required. A built-in damper, with which either model can be equipped, varies the outlet aperture uniformly without affecting the outlet velocity or diffusion pattern. Thus, the air direction and volume of the same KNO-DRAFT Diffuser can be adjusted to be equally effective in expelling chilled air parallel to the ceiling or ejecting heated air downward to prevent stratification.

With KNO-DRAFT Adjustable Diffusers many engineers have been able to insure efficient air distribution, maximum premixing of room and supply air, noiseless and draftless diffusion and uniform temperature throughout the occupied zone. And they have been able to reduce labor and sheet metal costs by distributing large volumes of air at higher duct velocities in smaller, simplified ducts with fewer outlets, because KNO-DRAFT Diffusers permit the use of higher neck velocities.

The W. B. Connor Engineering Corp. maintains a staff of specialists and district representatives in leading cities to assist you with any air distribution problem.

FREE HANDBOOK

Contains clear sketches, charts, dimension prints and instructive text that simplify the selection and installation of air diffusers. For your copy write Dept. D-9.

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Air Diffusion *Air Purification* *Air Recovery*

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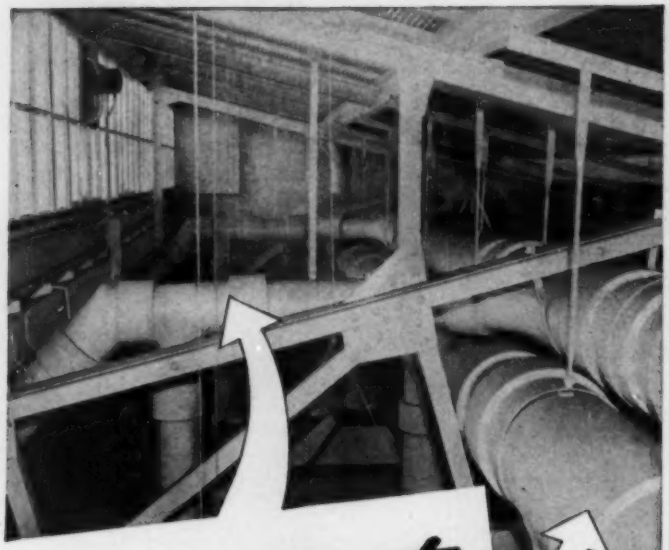

These Ducts defy Rust...

resist Corrosion by many industrial fumes, vapors, gases

Do rust and corrosion play havoc with your venting system?

Many users are finding that Transite "S" Pipe offers a practical answer to this problem. Made of asbestos and cement, it is completely rustproof . . . successfully resists many types of corrosion encountered in industrial venting systems. Rotproof and highly weather resistant, Transite "S" Pipe can be used either indoors or outdoors—for ducts, vents and stacks—without painting or other surface protection.

Installations such as the one shown present no problem because Transite "S" Pipe is light in weight, easily assembled, and comes in a range of 19 sizes—diameters from 2″ up to 36″. A complete line of fittings is also available.

For full information on Transite "S" Pipe, write for data sheets DS Series 336. Address Johns-Manville, 22 East 40th Street, New York 16, New York.

JM

Johns-Manville TRANSITE 'S' PIPE

Drayer & Hanson, Inc., 738 E. Pico Blvd., Los Angeles 21, Calif., in the form of a 21x26 in. wall chart.

Heating Problems

No. 5086—How the threefold problem of heating, cooling, and vapor dispelling was solved in a large meat processing plant is one of the stories in a recent issue (Vol. 9, No. 4) of Weather Magic, house organ of the Trane Co., La Crosse, Wis. Another story tells of the methods used to solve temperature and humidity problems in a military hospital in Mexico.

Hot Water Heating

No. 5087—The hot water controlled heat system of the Hoffman Specialty Co., 1001 York St., Indianapolis 7, Ind., is described in a two page bulletin (The Producers' Council—No. 48) which the company is now distributing.

Housing Project Heating

No. 5088—A plan for central heating and air conditioning in a proposed suburban apartment development is the subject of a 24 page booklet published by the Ric-wiL Co., 1562 Union Commerce Bldg., Cleveland 14, Ohio. The text discusses the economics of supplying heating, cooling, and other services to a planned housing project from a central source. A detailed factual analysis is given, with blueprints, cost tables, etc. An appendix describes a number of case histories where this sort of central heating has already been installed.

Humidity Control

No. 5089—A 16 page engineering data book (K-45) on "Kathabar" package units for humidity control has

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SPEED CLAMP on water valve of automatic home washer.

Latch by hand

Lock with pliers

Remove with screwdriver

SPEED CLAMP ADVANTAGES

1. One piece—no bolts, gears, thumbscrews.
2. Exclusive, self-locking, ratchet design.
3. Faster and easier to install or remove.
4. Uniform pressure provides leak-proof grip.
5. Low profile—no protruding mechanism.
6. May be used over and over again.

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2018 Fulton Road, Cleveland 13, Ohio

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FASTEST THING IN FASTENINGS...OVER 3000 SHAPES AND SIZES

Peerless presents the

Water King

PUMPING SYSTEM

275 to 1300 gallons per hr.

For shallow wells

100% Automatic

Embodies magic intracentric water-lift

Applying a revolutionary water-lifting principle, with a magic pumping element intracentrically positioned within the pump case, Peerless presents the most advanced Pumping System—the *Water King*. The pumping element is the famous Peerless Hi-Lift, ingeniously applied in simplest form. Pressure maintained automatically. Silent, smooth, non-pulsating operation. Pump can be installed over-well or off-set. Heavy-duty, capacitor type motor. 1/6 to 3/4 h.p. No moving parts below surface. Water-lubricated. No sand cutting. Streamline design.

Peerless JET Water System

Improved design. For deep or shallow wells. Over-well or off-set. Capacities 300 to 5000 gallons per hour. 100% automatic.

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PEERLESS PUMP DIVISION
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Do it *Quicker-Easier* with Tal's Prestal Pipe Bender

Bent with Byers Wrought Iron Pipe

You start saving valuable working time and reduce material costs the day you use a Tal Prestal Pipe Bender. This efficient, easy to operate, portable machine reduces by 60% the need for fittings or welds. It bends ⅜" to 3" wrought iron or steel pipe up to 180°, cold, in one single, fast operation without moving the pipe, without heating or filling. With a Tal Bender you get a job to be proud of, neat, smooth, workmanlike, free from kinks or wrinkles. Hundreds of leading contractors already know that this best engineered, money making machine repays its low cost over and over every few months. Write for bulletin . . . today!

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SUPERIOR DROP-FORGED TOOLS

"VULCAN SUPERIOR" CHAIN PIPE TONGS

7 sizes, with either Flat Link or Cable Chain, for pipe and fittings 1/8 to 12".

● Pipe or fittings—it makes no difference to "Vulcan Superior," the universal service tong. You can switch from one to another without adjustment or change of parts. And "Vulcan Superior" is the only chain tong with *reversible* pipe-and-fittings jaws. When one set of teeth begins to wear, simply remove the Through-Bolt and reverse the jaws. Sold by Plumbing Supply and Industrial Distributors everywhere. Literature on request.

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INSULATION

You see above how ducts look when applied with asbestos protected DUX-SULATION — the all purpose insulation. It is attractive and can be given any type of surface treatment.

DUX-SULATION saves 75% of the bare duct heat loss—has high thermal insulating efficiency of 70% (K factor .27 B.T.U.). Is ½" thick and has smooth surface giving an exceptionally low frictional resistance (F = 0.0001322).

DUX-SULATION also deadens metallic noises when applied to outside of ducts and will absorb 70% of air borne noises in less than 10 lineal feet of lined duct.

DUX-SULATION comes complete—nothing else to buy — 36" wide roll contains 100 sq. ft. Quick and easy application;—Shipped complete with sufficient adhesive to glue the felt on to metal duct surfaces and special tape for corners and joints.

DUX-SULATION does much more. The story is told in our valuable free book No. 407-P. Be sure to fill in and mail the coupon below to get all these money-saving facts.

Find out why contractors and plant operators prefer DUX-SULATION year after year.

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Send Bulletin No. 407-P containing the full story of DUX-SULATION—the all purpose insulation.

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been issued by the Surface Combustion Corp., 2375 Dorr St., Toledo 1, Ohio. Included are descriptions of typical applications with specifications in chart and tabular form, as well as a general description and an explanation of the principles of control and operation of the system. There are also two psychrometric charts.

Industrial Insulation

No. 5090—Four types of industrial insulation—85 per cent magnesia, high temperature covering, laminated asbestos paper pipe insulation, and air cell—are briefly described in a two page bulletin (The Producers' Council—No. 48) which is available from the Armstrong Cork Co., Lancaster, Pa.

Insulating Glass

No. 5091—"Thermopane," an insulating window glass, is described in a two page bulletin (The Producers' Council—No. 48) now being distributed by the Libbey-Owens-Ford Glass Co., Nicholas Bldg., Toledo 3, Ohio.

Lead Lined Steel Pipe

No. 5092—Three booklets have been published by the American Smelting & Refining Co., 120 Broadway, New York 5, N. Y., describing lead lined steel pipe and fittings (20 pages), lead and lead lined valves (44 pages), and prefabricated lead fittings (24 pages). The information is intended to be of help to piping contractors who are faced with acid corrosion problems. The general features and uses of these products are described in detail and fully illustrated.

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DIAL
THERMOMETER
Economize WITH POWERS
TEMPERATURE REGULATORS
POWERS
Use a Powers No. 11 Temperature Indicating Regulator when you want the advantages of an easy-to-read dial thermometer combined with a dependable self-operating regulator. The dial thermometer gives a visual check on the performance of the regulator and makes it easy to adjust for the required operating temperature. Various dials and ranges are available.
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CONTROLS HEATING OR COOLING MEDIUMS
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OVER 50 YEARS OF AUTOMATIC TEMPERATURE AND HUMIDITY CONTROL

PLASTIC FAN BLADES AND BLOWER WHEELS

BETTER FAN satisfaction is assured when you equip your fans with Burden Plastic Blades. These quiet propeller type modern blades have a much lower noise level. They have longer life and weigh only 1/5th to 1/4th as much as metal blades. Yet they have the same structural strength. Burden Blades have been tested from—60 to 300 F. They are resistant to corrosive action. Low moisture absorption.

3 TYPES — MANY SIZES

Overlapping — Cloverleaf — Single Blade

Also Complete Line of Aluminum Blades.

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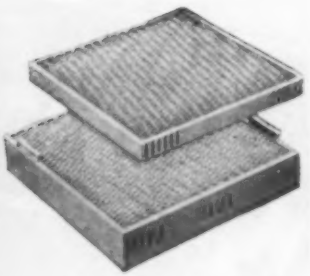
FOR IMPROVED AIR FILTERING... GREATER CAPACITY ...REDUCED COSTS



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Specially Designed for extra heavy duty and industrial air cleaning services, the BADGER Heavy Duty Permanent Filter provides definitely improved air filtering, lower air resistance, greater dust-holding capacity, as well as reduced costs of maintenance. In addition, longer filter life is assured. Built in 2" and 4" sizes.

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Statement of Ownership and Management of HEATING, PIPING & AIR CONDITIONING for October 1, 1945

The following is a statement of ownership, management, etc., as required by the Acts of Congress of August 24, 1912, and March 3, 1933, of Heating, Piping & Air Conditioning, published monthly at Chicago, Ill., for October 1, 1945:

State of Illinois, County of Cook, ss.: Before me, a Notary Public in and for the State and county aforesaid, personally appeared F. P. Keeney, who, having been duly sworn according to law, deposes and says that he is the Publisher of Heating, Piping & Air Conditioning, and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management, etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, as amended by the Act of March 3, 1933, embodied in section 537, Postal Laws and Regulations, to wit:

1. That the names and addresses of the publisher, editor, managing editor, and business manager are:

Publisher, F. P. Keeney, Chicago, Illinois.
Editor, C. M. Burnam, Jr., Chicago, Illinois.
Managing Editor, C. M. Burnam, Jr., Chicago, Illinois.
Business Manager, Chas. E. Price, Chicago, Illinois.

2. That the owner is: (If owned by a corporation, its name and address must be stated and also immediately thereunder the names and addresses of stockholders owning or holding one per cent or more of total amount of stock. If not owned by a corporation, the names and addresses of the individual owners must be given. If owned by a firm, company, or other unincorporated concern, its name and address, as well as those of each individual member, must be given.)

Keeney Publishing Company, 6 North Michigan Avenue, Chicago 2, Illinois. Stockholders: F. P. Keeney, Chicago, Illinois; W. J. Osborn, Fairfield, Conn.; R. P. Wettstein, Los Angeles, Calif.; Chas. E. Price, Chicago, Illinois; Robert A. Jack, Cleveland Heights, Ohio.

3. That the known bondholders, mortgagees, and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages, or other securities are: None.

4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company, but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

F. P. Keeney, Publisher.

Sworn to and subscribed before me this 18th day of September, 1945.

Grace E. Waymire.

(SEAL) [My commission expires February 10, 1946]

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Prevents ALGAE AND SLIME *IN AIR CONDITIONING*

NOT A SCOURING AGENT . . .

A Proven Preventive

★ ***Reduces Bacterial Content*** **in air going thru system from 60 to 90%.**

★ ***Reduces Labor*** **because frequent cleaning of jets and baffle plates is no longer necessary.**

★ ***Proved and Accepted,*** **has been used by large firms for over 4 years.**

★ **NON-VOLATILE . . . ODORLESS.**

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ROUGH edges and inferior pipe are a plumber's nemesis. For easy cutting and resultant clean edges, WHEATLAND produces superlative steel pipe, both serviceable and long-wearing. WHEATLAND takes to the plumber's hand-cutter as a man to a steak. Win new trade friends by virtue of an old friend—WHEATLAND.

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WHEATLAND TUBE COMPANY

Liquid Meter Valves

No. 5093—Liquid meter valves and slides of "Morganite"—a substance made from graphite, petroleum coke, lamp black, and retort carbon combined with pitches, tars, and other binders—are described in a six page folder of the Morganite Brush Co., Inc., Long Island City 1, N. Y. The physical characteristics and chemical properties of the substance are outlined.

Mercury Clutch

No. 5094—The "Mercury Midget," an automatic, mercury actuated clutch, is described in a four page bulletin (108) issued by the Mercury Clutch Corp., 1504 12th St., S. W., Canton, Ohio. It was developed to overcome problems in the application of ¼ hp motors to the drives of such equipment as air conditioners, refrigerators and other electrically driven machinery. The operation of the clutch is shown in dimensional drawings and charts.

Mineral Wool Insulation

No. 5095—A one page article explaining the importance of warm walls for comfort in the heating season and the advantages of insulation in heating is being distributed by the National Mineral Wool Association, 1270 Sixth Ave., New York 20, N. Y. Accompanying the article is a chart for calculating inside wall temperature in any weather.

Packings Design

No. 5096—Information concerning the selection of cup, flange, "U," and "Vee" packings is contained in a

Here's Money-Saving Protection For Your Compressed Air Operated Machinery and Instruments

Now, regardless of volumes required or fluctuating pressures, the new Bird-White Pur-O-fiers completely and effectively remove all moisture, oil, dirt and other foreign matter from compressed air or gas lines—preventing costly corrosion and gumming in compressed air-operated machinery and instruments.

Operating on the principle of centrifugal action, a high speed Turbo-rotor forces the tiny particles of foreign matter outward where they are trapped and drained off.

Single units can accommodate up to 100 cubic feet. Above this range multiple units are recommended.

New applications for Bird-White Pur-O-fiers are being developed every day. Write for Bulletin No. 10 giving complete information.

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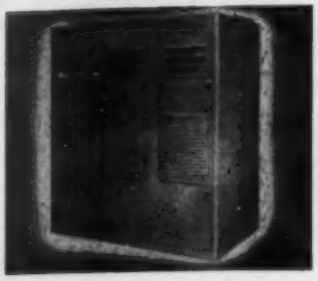
WHEN YOU THINK OF HEATING, THINK OF

Palmaire

GAS FURNACES

made in palm-lined Phoenix, Arizona

A new brand-name to help you remember this quality line of gas heating equipment, in sizes and types for every need.



Palmer furnaces range in size from wall and floor furnaces for small homes to the large central heating forced air furnace (as shown) for stores and factories.

Write for free folder. Palmer MFG. CORP.

PHOENIX, ARIZONA

Here's why GRID UNIT HEATERS

are permanent heating Equipment

HIGH TEST CAST IRON HEATING SECTIONS

GRID High Test Iron Unit Heaters are made to last—to last as long as the pipes furnishing steam to them, because the "fin" heating sections are made of the metal for permanency. That's why they are free from maintenance expense. Many units have been operating continuously for over 15 years. Here's why GRID High Test Cast Iron Unit Heaters are permanent heating equipment:

- One piece construction heating sections (patented) of high test cast iron that withstand steam pressures up to 250 lbs.
- No soldered, brazed, welded or expanded connections to become loose or develop leaks.
- No electrolysis to cause corrosion, breakdowns, leaks, or heating failures.

Complete data and capacity tables upon request.

SEND

For new booklet "Corrosion in Unit Heaters"—free upon request.

D. J. MURRAY MANUFACTURING CO.

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The Air Conditioning Equipment Drive
for Long, Trouble-Free Service

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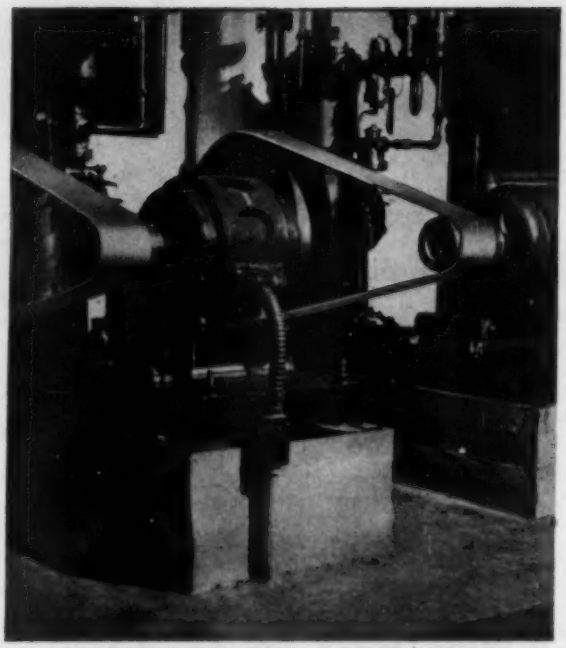

The automatically controlled belt tension provided by the weight of the motor on the Rockwood Pivoted Motor Base keeps efficiency high at all times. This is further aided by the firm grip of the Tannate Leather Belt which assures smooth running and a steady pull.

Because Tannate also has exceptional flexibility, strength and endurance, the life of the drive is long . . . with practically no maintenance.

Write us for further details.

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PRODUCTION DRIVE

—Established 1702—

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24 page folder issued by the Graton & Knight Co., 288 Franklin St., Worcester 4, Mass., being presented as a series of 12 articles titled Packing Pointers. Also included is an illustrated text on the correct design of machine parts adjacent to mechanical packings.

Pipe and Tube Bending

No. 5097—Bending, forming, and fabrication of pipe and tubing—services offered by the Swan Engineering Co., Inc., 740 Frelinghuysen Ave., Newark 5, N. J.—are described in a four page bulletin and leaflet recently published.

Plastic Gasket Material

No. 5098—"Plastic-Gasket," type of gasket material designed to replace cut gaskets in many installations, is described in a 10 page leaflet of the Flexrock Co., Packing Div., Filbert & Cuthbert Sts., Philadelphia 4, Pa. Also covered are "Turboseal," a heavy duty seal for boilers, diesel engines, etc., and "Pipeasy" pipe thread compound.

Plastic Visual Panels

No. 5099—The use of transparent panels (made from allyl alcohol based plastics) in the cabs of overhead traveling cranes is described in a two page reprint being distributed by the Cleveland Crane & Engineering Co., Wickliffe, Ohio.

Return Traps

No. 6000—An eight page bulletin being distributed by Templeton Bros., Inc., 699 Main St., Walpole, Mass.

WHY SPEED NUTS ARE FIRST WITH *Purchasing Agents*

NOTHING LOCKS LIKE A SPEED NUT

Only SPEED NUTS provide a COMPENSATING thread lock and a SELF-ENERGIZING spring lock. As the screw is tightened the two arched prongs move inward to lock against the root of the screw thread. These free-acting prongs COMPENSATE for tolerance variations. Compression of the arch in prongs and base creates a SELF-ENERGIZING spring lock. These two forces combine to definitely prevent vibration loosening.

LOWER COSTS . . . reduced inventories . . . fewer handling problems . . . availability of Speed Nuts.

Their initial cost, in many cases, is less than ordinary fasteners. Savings in assembly time and reduction in number of parts makes net assembly costs really take a tumble.

SPEED NUTS keep inventories down. Completely do away with washers. Often eliminate many other assembly parts. This means quick inventory turnover.

Unlimited production and service facilities assures getting SPEED NUTS on their way to you . . . on time. SPEED NUTS should be YOUR first choice, too. Write for information today.

TINNERMAN PRODUCTS, INC., 2018 Fulton Road, Cleveland 13, Ohio

Speed Nuts

FASTEST THING IN FASTENINGS . . . OVER 3000 SHAPES AND SIZES

Dependable! Efficient! Lasting!

APCO CONDENSATION RETURN UNITS
Simplex and Duplex
also
AURORA VERTICAL UNITS
Sizes up to 150 G. P. M.

—Available for Sale with Profit this Season

PUMPS "by Aurora" are PUMPS you can TRUST

Type OD Hor. Split-Case Double Suction Single Stage Centrifugal

Aurora Deep Well Turbines—4" to 24"

Apco Turbine-Type Pumps The simplest of all pumps. Ideal for small capacity, high head duties. Silent, compact and lasting.

NSA Aurora Centrifugal Sump Pump

Type GMC Close-Coupled Centrifugal

Type GGU Side Suction Single Stage Centrifugal

APCO Single Stage Turbine-Type

Write for CONDENSED CATALOG M or See Our Catalog in SWEETS.

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AURORA Always PUMPS

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60 Loucks Street, AURORA, ILLINOIS

We have built, are building, and shall continue to build all types of custom-made coils for air conditioning and refrigeration equipment.

It will cost you nothing to ask us for a quotation on your requirements.

SWAN ENGINEERING CO., INC.

28-58 Nelson Street
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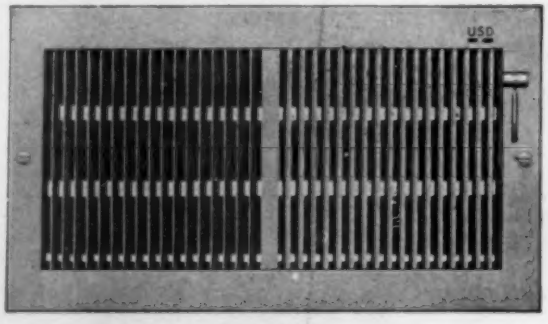

No. 4432

AIRO-FLEX ADJUSTABLE

AIR DIRECTIONAL REGISTERS

Auer Airo-Flex Registers furnish effective 4-way directional flow. Multi-louvre back-blades control up-and-down flow, and indicator on face shows position of blades. Vertical grille bars are easily adjustable for straight or sideway deflection, with turning tool. The Airo-Flex design has all adjustable features of many higher priced registers. Furnished for wall or baseboard use, with matching intake.

Many other styles of Auer registers for both air conditioning and gravity systems shown in Auer Register Book, sent on request. For flat stamped metal grilles, ask for catalog "G."

THE AUER REGISTER CO.
3608 Payne Avenue, Cleveland 14, O.

AUER REGISTERS
& GRILLES For Air Conditioning *and* Gravity

PRODUCTS RESEARCH CO.
634 S. WESTERN AVE.
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Chrome Lock for Air Conditioning

THE MANY FEATURES of the new Chrome Lock Gasket make it ideal for air conditioning work. Chrome Lock is an entirely new type of gasket made of a felt base impregnated with a chromate pigmented compound which renders it flame and corrosion-resistant. Chrome Lock Gasketing tightly seals the joints in air ventilator lines and forced draft blowers with an air pressure resistance up to 500 lbs. Chrome Lock has excellent adhesion to metals. It is pliable—easily worked—non-corrosive —rust-arresting.

Chrome Lock

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Without obligation, send me FREE sample of Chrome Lock Gasketing.

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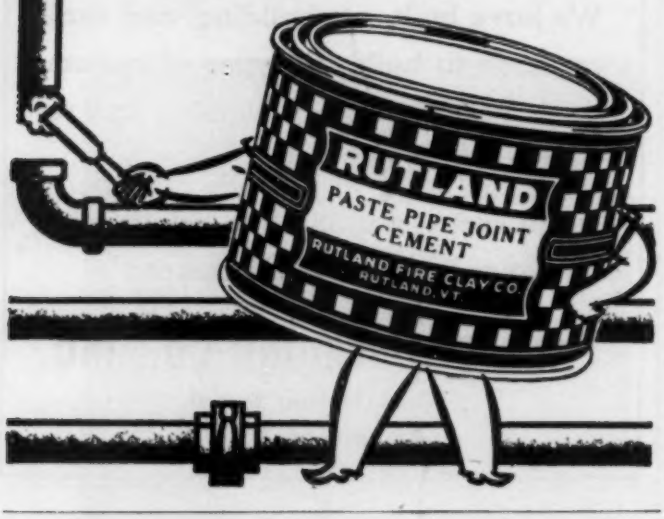
The No-Stain Pipe Joint Cement

Using Rutland Pipe Joint Cement saves a lot of cleaning up afterwards. It does not stain hands or fixtures. Also, Rutland seals joints tightly and lasts indefinitely —but always leaves pipes easy to disjoin. Remains soft in can.

Mail post card for free sample. Rutland Fire Clay Company, Department H-30, Rutland, Vt. Also makers of Rutland Retort Cement, Furnace Cement, Asphalt Paint, Concrete Patcher.



describes return traps for pumping and boiler feeding, draining heaters and vacuum lines, and for creating vacuum on low pressure return lines. Included are diagrams, photographs, and capacity tables.

Silicones

No. 6001—Products made from silicone—a synthetic material composed of silicon and oxygen atoms—are described in an 11 page bulletin published by the Dow Corning Corp., P. O. Box 592, Midland, Mich. Charts and graphs demonstrate the properties of this material which is employed in making heat transfer fluids, lubricants, synthetic rubber, varnishes and resins, and sealing compounds.

Steel Tubing Pressure Chart

No. 6002—An internal pressure chart for round steel tubing has been issued by the Baker Steel & Tube Co., Los Angeles, Calif. It is designed to show a safe working pressure for tubing with outside diameters up to 10 in., wall thickness from 0.035 to 1 in., ultimate tensile strength of steel from 40,000 to 100,000 psi., and safety factors from two to six. The calculations are based on cold drawn, average wall steel tubing. An example is worked out on the chart, with arrows indicating the procedure to follow.

Tank and Process Temperature Controls

No. 6003—Temperature controls for tank and process installations are the subject of a four page bulletin (451) of Sterling, Inc., 3738 N. Holton St., Milwaukee 11, Wis. Included are data on sizes, capacities, and temperature ranges as well as photographs and dimensional drawings.

Is there a **THIEF** in your air conditioning system?

Spray Nozzles are always an important factor in obtaining efficiency in an air conditioning and cooling system. Spraying Systems nozzles, hydraulically engineered and precision built, can provide atomization and distribution exactly as required for any given water volume and pressure. Spray Nozzles are available for every air treatment problem in a range of sizes to meet any specification. Write for Catalog No. 22 . . . a 30-page Spray Nozzle reference manual.

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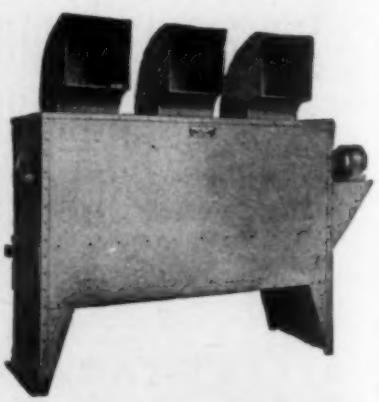

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Division of
ST. LOUIS BLOW PIPE and HEATER CO., INC.
1948 North Ninth Street, St. Louis 6, Missouri

Temperature Control Valves

No. 6004—A four page bulletin issued by the Douglass Automatic Controls Co., 4505 E. Firestone Blvd., South Gate, Calif., describes temperature control valves of throttling type to control the fuel supply thermostatically. They are used in controlling the temperature of liquids in such applications as oil dehydrators, instantaneous or storage water heaters, etc. Operating information, specifications, and prices are listed.

Thermostats and Pressure Switches

No. 6005—A new 12 page condensed catalog and price sheet (4951-C) on temperature and pressure controls has been issued by the United Electric Controls Co., 69-71 A St., Boston 27, Mass. Specifications are given in tabular form throughout, and each model is shown in photographs.

Threadless Connection

No. 6006—The "Silbraz" joint—a threadless connection that is said to bond copper tubing and brass pipe into a single pipe line—is described in a 16 page booklet (ADG-2017) which is being distributed by the Air Reduction Sales Co., 60 E. 42nd St., New York 17, N. Y. Photographs and text show how the joint is made and how it is applied, while other sections describe the "Aircobraze" outfit for use in making these joints.

Tubing Pressure Chart

No. 6007—A diagram designed to show safe working pressures for small hydraulic stainless steel tubing has been released by the Baker Steel & Tube Co., Los An-

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The Austin Company is offering opportunities to Engineers who can design and/or prepare engineering drawings for industrial buildings and their facilities. Assignments are not for specific projects but are in our regular engineering staffs in long established offices, located on the East Coast, Central West, Gulf Coast and West Coast.

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HAINES Traps are *always* safe! The Haines underslung valve principle on the Float & Thermostatic Traps assures this. There is no danger of building up a pressure.

Haines Traps contain the famous Bourdon Thermostatic Tube, the strongest thermostat ever built into a steam trap. The Bourdon Tube is used in fine gauges where accuracy is paramount; therefore, Haines Traps always give accurate performance.

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Vento Radiator Trap

Haines Float and Thermostatic Traps are designed for any low pressure job up to 20 lbs. in the ¾" size and 30 lbs. in the 1" and 1¼" sizes.

F & T Trap

DE-STA-CO Blower Wheel Housings

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Made in sizes to fit 4½, 5, 6, 7½ and 9 inch wheels and in widths to suit single or double inlet wheels . . . also individual parts for your own assembly.

De-Sta-Co housings are engineered for maximum efficiency and quietness in operation . . . neatly finished. Send for "De-Sta-Co Blower Housings" bulletin; gives complete information, including essential dimensions.

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Assure Leak-Proof Connections By Sealing *with* KEY Graphite Paste

You can be sure that thread and gasket connections on high pressure steam lines are leak proof when you seal them with Key Graphite Paste. The compound expands under heat to provide a perfect seal, yet will not freeze the connection in service.

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To assure accuracy AT-A-GLANCE Gauges are NON-ADJUSTABLE, but are accurately adjusted at the factory to fit all sizes of fuel oil storage tanks according to individual specifications. AT-A-GLANCE Gauges are also available for any special sized tanks.

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AT-A-GLANCE Gauges are the easiest reading gauge on the market. That red indicator disc can be seen from any direction and at a great distance.

AT-A-GLANCE Gauges can't be beat for dependability and long life. They contain no gears, magnets, springs nor intricate mechanism to wear out or to get out of adjustment.

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Write for complete details today.

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KRUEGER SENTRY GAUGE COMPANY

1056 West Mason Street Green Bay, Wisconsin

geles, Calif. The chart covers outside diameters from ⅛ to 1 in., wall thicknesses of 0.009 to 0.065 in., ultimate tensile strength from 30,000 to 120,000 psi, and safety factors from two to six inclusive. Also shown is the weight of the tubing in lb per lineal ft. An example is worked out on the chart, with arrows indicating the procedure to follow.

Tubing Tools

No. 6008—A tube working tool selector is one of the features of a 16 page leaflet (347) on tools for use with copper, brass, aluminum, thin wall steel, and similar tubing, issued by the Imperial Brass Mfg. Co., 1200 W. Harrison St., Chicago 7, Ill. Flaring tools, tube cutters, tube benders, coil makers, pinchoff tools, and soldering equipment are all included, as well as a number of tool kits.

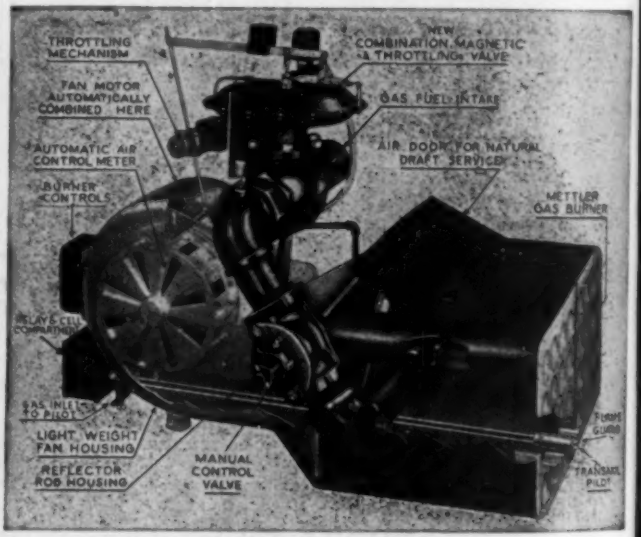
Vacuum Steam Control

No. 6009—A method of steam control designed to change a vacuum return system into a high vacuum sub-atmospheric system is described in an eight page bulletin of the All-Vac Steam Control System, 3145 N. Mascher St., Philadelphia 33, Pa. Included is a list of some of the users of the system.

Water Treatment

No. 6010—The use of colloids (tiny particles which react physically rather than chemically) in boiler water treatment is described in a four page bulletin (33) released by the American K. A. T. Corp., 331 Madison Ave., New York 17, N. Y.

The Mettler "FAN-AIR" Gas Burner



Picture reveals essential & highly desirable POINTS of Fan-Air mech'l draft gas burners. Not just a gas burner but a COMPLETE AND FULLY AUTOMATIC BURNER SYSTEM, factory tested and ready for application when received. Its the most modern gas burner and easier to install.

(NOTHING ELSE LIKE IT)

SIZES 5 TO 300 H.P. PROMPT SHIPMENTS

Mettler Entrained Combustion Gas Burners

FOR ALL Purposes Kinds of gas Pressures

Write for Catalog

LEE B. METTLER CO.

406 S. Main St. Los Angeles, Cal.

Welding Accessories

No. 6011—A new 16 page catalog (40) on "Airco" gas welding and cutting supplies and accessories has been published by the Air Reduction Sales Co., 60 E. 42nd St., New York 17, N. Y. The types of equipment described include welding rods, brazing and welding fluxes, hose, brazing alloys, goggles and spectacles, gloves, and sparklighters and tips, as well as many other items. Photographs and sketches illustrate the text.

Welding Instruction

No. 6012—A revised 16 page manual (416), "Building Your Career in Arc Welding," and a two page leaflet (699) on welding engineering have been published by the Lincoln Electric Co., 12818 Coit Rd., Cleveland 1, Ohio. The manual describes the welding instruction sponsored by the company, and the leaflet outlines briefly a course in welding design and procedure.

Blower Division Moves

The Herman Nelson Corporation, 1824 Third Ave., Moline, Ill., has announced that the manufacturing operations of its blower division will be transferred from Chicago to a 55,000 sq ft plant in Moline. This plant, which was constructed for war work, is readily adaptable for conversion to the manufacture of blowers, says the manufacturer. Transfer of equipment is already under way and is expected to be completed in November.

How equipment, fuel and energy were saved in the Criminal Courts Building, New York

See W. B. Connor Engineering Corp. "Aditorial" on pages 28-29 of this issue, Heating, Piping and Air Conditioning.

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DESIGNED FOR COOLING TOWERS AND EVAPORATIVE COOLERS. HAS MANY OTHER USES

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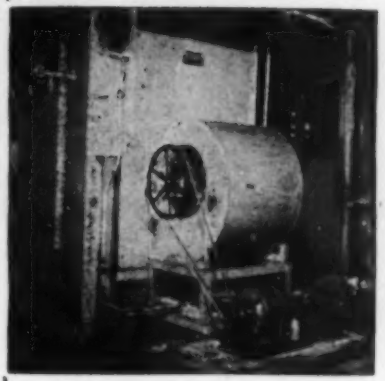

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Tray Cooling Towers for indoor and outdoor installation, meet today's requirements for economy, efficiency and long life. Tray Cooling Towers are made in both atmospheric and mechanical draft types. Units are all steel, with open distributor header, no nozzles, and with slow-speed fans. Available in package units from 10 G.M.P. up. Write for bulletin number 45 today.

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LEAKAGE?

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TEMPLETON RETURN STEAM TRAPS
for Pumping Boiler Feeding, Draining, Heating and Vacuum Lines

Pumps Water at any temperature or pressure.
Open float cannot burst or waterlog.
Valves and Seat Bronze or Stainless Steel.
Sizes 1 in. to 4 in. inlet and outlet.
Capacity 2500 lbs. to 60,000 lbs. water discharge per hr.

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Architectural Steel Concrete, Mechanical, Piping & Electrical Draftsmen
Permanent Positions
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CONTRACT MANAGER—Preferably graduate engineer, to assume complete management of Midwestern pipe covering operation. Knowledge of pipe covering sales, estimating, job organization and supervision essential. Excellent opportunity with old established company. Please write fully. Address Key No. 507-A, Heating, Piping & Air Conditioning, 6 No. Michigan Ave., Chicago 2, Ill.

FAN ENGINEER OR DRAFTSMAN—Southern Ohio well-known Axial Fan and Blower manufacturer requires services of a good man already experienced in fan engineering. College man preferred, but not necessary. Excellent future. Address Key No. 506-A, Heating, Piping & Air Conditioning, 6 No. Michigan Ave., Chicago 2, Ill.

WANTED—Engineering draftsman capable of designing heating, plumbing layouts. Must be good draftsman. Long term employment in desirable section of Virginia. Give age, education, previous experience and state minimum salary acceptable. Address Key No. 524-A, Heating, Piping & Air Conditioning, 6 North Michigan Ave., Chicago 2, Illinois.

HELP WANTED

Mechanical engineer—draftsmen experienced in design and layout of commercial heating and plumbing systems. College men preferred. Permanent positions with national merchandising organization. Please give complete information on education and experience. Address Key No. 516-A, Heating, Piping & Air Conditioning, 6 No. Michigan Ave., Chicago 2, Ill.

WANTED—Mechanical engineer with design experience in heating, ventilating and air conditioning. Hourly basis, time and a half over forty hours. Established engineering office Atlantic Seaboard. Give all particulars in letter. Salary commensurate with ability and experience. Address Key No. 515-A, Heating, Piping & Air Conditioning, 6 N. Michigan Ave., Chicago 2, Ill.

Sales Representative—Wanted for New York office of well-known manufacturer of fans, blowers, and unit heaters. Must have engineering background and experience in ventilating, air conditioning, and heating fields. Write us in detail giving age, experience, salary desired, and availability. Address Key No. 520-A, Heating, Piping & Air Conditioning, 6 North Michigan Ave., Chicago 2, Ill.

Established Cincinnati, Ohio, Company representing a nationally known equipment manufacturer is in need of an engineer with not less that five (5) years' current experience in layout, design and estimating Air Conditioning Systems. Give full history of your experience, salary expected, and availability in letter. Confidential. Address Key No. 519-A, Heating, Piping & Air Conditioning, 6 North Michigan Ave., Chicago 2, Ill.

REFRIGERATION ENGINEER—One capable of assuming full responsibility for design and development of automatic control equipment for commercial refrigeration and air conditioning. An excellent opportunity for one with at least ten years' experience and thoroughly reliable. Address Key No. 504-A, Heating, Piping & Air Conditioning, 6 N. Michigan Ave., Chicago 2, Ill.

HELP WANTED

MECHANICAL ENGINEER and draftsman, recent graduate preferred, to design residential heating equipment. Permanent position, northern Ohio. State age, experience, salary expected and present status in confidential letter. Address Key No. 513-A, Heating, Piping & Air Conditioning, 6 N. Michigan Ave., Chicago 2, Ill.

Opportunity is available for Sales Representatives for an extensively used and proven Thermostatic Draft Control for both high and low pressure boilers. Installations have solved heating problems and substantially reduced fuel costs in many industrial plants and large buildings. Applications will be considered only from competent heating engineer with satisfactory credit rating and facilities for installations. Address Key No. 511-A, Heating, Piping & Air Conditioning, 6 No. Michigan Ave., Chicago 2, Ill.

Young engineer experienced in heating, ventilating and air conditioning, some knowledge of plumbing desirable, for Estimator and General Assistant in Contractor's Office engaged in large Government contracts. Permanent position for the right party. Person with the proper knowledge and qualifications will find great possibilities for advancement. Applications will be kept strictly confidential. Please give all qualifications with application. Address Key No. 522-A, Heating, Piping & Air Conditioning, 6 North Michigan Ave., Chicago 2, Ill.

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and
DESIGNING PIPING ENGINEER
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